

# HISTORY, POLICY AND PROGRAM OF THE HUNTINGTON WILDLIFE FOREST STATION

By

R. T. King, W. A. Dence and W. L. Webb



## Roosevelt Wildlife Bulletin

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# CONTENTS OF RECENT ROOSEVELT WILDLIFE BULLETINS AND ANNALS

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## BULLETINS

### ROOSEVELT WILDLIFE BULLETIN, Vol. 5, No. 1. March, 1928.

1. A Preliminary Wild Life and Forest Survey of Southwestern Catta-  
raugus Co., N. Y. .... Victor H. Cahalane
2. A Preliminary Report on the Trout Streams of Southwestern Catta-  
raugus Co., N. Y. .... Wilford A. Dence  
(Out of print)

### ROOSEVELT WILDLIFE BULLETIN, Vol. 5, No. 2. February, 1929.

1. The Fishes of the Cranberry Lake Region.....  
W. C. Kendall and W. A. Dence
2. The Story of King's Pond.....F. A. Lucas
3. Its Fish Cultural Significance.....W. C. Kendall

### ROOSEVELT WILDLIFE BULLETIN, Vol. 5, No. 3. September, 1929.

1. The Summer Birds of the Northern Adirondack Mountains.....  
Aretas A. Saunders
2. The Summer Birds of the Adirondacks in Franklin County, N. Y.....  
Theodore Roosevelt, Jr., and H. D. Minot  
(Reprinted. Original date of publication, 1877)

### ROOSEVELT WILDLIFE BULLETIN, Vol. 5, No. 4. August, 1930.

1. The Biology of the Voles of New York.....Robert T. Hatt
2. The Relation of Mammals to the Harvard Forest.....Robert T. Hatt

### ROOSEVELT WILDLIFE BULLETIN, Vol. 6, No. 1. March, 1931.

1. A Biological Reconnaissance of the Peterboro Swamp and the Labrador  
Pond Areas .....Charles J. Spiker

### ROOSEVELT WILDLIFE BULLETIN, Vol. 6, No. 2. October, 1933.

1. The White-tailed Deer of the Adirondacks.  
Part 1. Preliminary Survey of the White-tailed Deer of the Adiron-  
dacks.....M. T. Townsend and M. W. Smith  
Part 2. Ecology of the White-tailed Deer in Summer with Special  
Reference to the Adirondacks .....  
M. T. Townsend and M. W. Smith
2. Some Late Winter and Early Spring Observations on the White-tailed  
Deer of the Adirondacks .....Chas. J. Spiker

### ROOSEVELT WILDLIFE BULLETIN, Vol. 6, No. 3. July, 1935.

1. A Popular Account of the Bird Life of the Finger Lakes Section of New  
York, with Main Reference to the Summer Season..Chas. J. Spiker

### ROOSEVELT WILDLIFE BULLETIN, Vol. 6, No. 4. January, 1937.

1. Part I. Preliminary Reconnaissance of the Land Vertebrates of the  
Archer and Anna Huntington Wild Life Forest Station.....  
Charles E. Johnson
2. Part II. Preliminary Reconnaissance of the Waters of the Archer and  
Anna Huntington Wild Life Forest Station and their Fish  
Inhabitants.....Wilford A. Dence

### ROOSEVELT WILDLIFE BULLETIN, Vol. 7, No. 1. October, 1937.

1. The Effect of Deer Browsing on Certain Western Adirondack Forest  
Types .....John Pearce

### ROOSEVELT WILDLIFE BULLETIN, Vol. 7, No. 2. October, 1939.

1. The Ecology and Economics of the Birds along the Northern Boundary  
of New York State.....A. Sidney Hyde

# ERRATA

- p.389 Hon. Charles Poletti should be listed as an Ex Officio Trustee.
- p.394 "Status of various vertebrate species" page 447 to page 448.
- p.396 17th line from top. Add comma after "King".
- p.397 11th line from top. Add comma after "Dance".  
6th line from bottom comma after "Dance".
- p.406 24th line from top. Change "Heavy 120" to "Heavy 141".  
3th line from bottom "Catalogue" for "Description".
- p.410 5th line from bottom "provision" for "provisions".
- p.415 24th line from top. "reducing" for "eliminating".
- p.416 3rd line from top. Add comma after "cover".
- p.417 Add hyphen in "check area" in cut.
- p.419 21st line from top. Add "of" after "degree".  
11th line from bottom. "Indispensable" for "Indispensible".
- p.435 2nd line from bottom. Add comma after "females".
- p.436 11th line from top. Add comma after "Dance".  
23rd line from top. Hyphenate "remarks".  
3rd line from bottom. Add "story" after "Ruffed Grouse".
- p.438 12th line from bottom. "on" for "at".
- p.440 10th line from bottom. "three" for "two".
- p.445 First sentence to read "A considerable number of deer that have failed to survive the rigors of winter are found each year, especially during late winter".
- p.446 Line 3. "provide" for "provids"
- p.457 Line 16 from bottom. "Hecomb" for "Hecomb".
- p.458 Line 17 from top. Add period after "Cassidy".
- p.459 Line 17 from bottom. "H.E.Heddy" for "H.E.Heddy".
- p.463 Line 13 from bottom. "outdoorsmen" for "outdoors-man".
- p.483 Line 1. Hyphenate "fur bearers".
- p.487. "Persistence" for "persistence" in cut.
- p.494. Line 21 from top. Add dash after "foo" at end of line.
- p.496 Line 9 from top. Hyphenate "fur bearers".



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## Roosevelt Wildlife Bulletin

VOLUME 7

NUMBER 4

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## ANNOUNCEMENT

The serial publications of the Roosevelt Wildlife Forest Experiment Station consist of the following:

1. Roosevelt Wildlife Bulletin.
2. Roosevelt Wildlife Annals.

The *Bulletin* is intended to include papers of general and popular interest on the various phases of forest wildlife, and the *Annals* those of a more technical nature or having a less widespread interest.

The editions of these publications are limited and do not permit of general free distribution. Exchanges are invited. Sale prices for the Station publications are based on the actual cost of printing and distribution in accordance with Chapter 220 of the Laws of 1933. Price lists will be furnished on request. All communications concerning publications should be addressed to

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### Temporary Appointments

The regular staff is frequently supplemented by temporary help, usually naturalists from specialized fields of biology. Likewise two or more graduate students majoring in the field of wildlife management are required to assist in the field projects that are in progress at the Huntington Wildlife Station in the Adirondacks.

## GENERAL CONTENTS

PAGE

Part I.	History, Policy and Program of the Huntington Wildlife Forest Station. R. T. King, W. A. Dence and W. L. Webb.....	393
Part II.	Forest Zoology and Its Relation to a Wildlife Program on the Huntington Forest. R. T. King.....	461



Fig. 76. The staff and crew of the Huntington Forest, summer 1940. Back row (left to right): R. T. King, Director; A. E. F. Miller; W. A. Dence, Assistant Director; A. W. Roberts, Jr.; Karl Leebrick, L. C. Stegeman. Front row (left to right): Neil Croom, M. Alexander, H. F. Heady, Frank Barick, Helmut Buechner, W. L. Webb, W. D. Fitzwater.



Fig. 77. The dormitory. Sleeping quarters upstairs and in wing at right.

# HISTORY, POLICY AND PROGRAM OF THE HUNTINGTON WILDLIFE FOREST STATION

By

R. T. KING, W. A. DENCE AND W. L. WEBB

*Roosevelt Wildlife Forest Experiment Station  
Syracuse, New York*

## CONTENTS

	PAGE
Founding—New York State College of Forestry.....	394
Founding—Roosevelt Wildlife Forest Experiment Station.....	395
Organization .....	395
Purposes .....	395
Activities and accomplishments.....	396
Present policy and program.....	400
Huntington Forest .....	402
Acquisition .....	402
Personnel .....	402
Description .....	403
Physical developments on the Huntington Forest.....	406
Truck trail .....	407
Foot trails .....	407
Buildings .....	409
Telephone line .....	410
Dams .....	410
Miscellaneous physical developments.....	410
Roosevelt Station program.....	411
Policy .....	411
Purpose .....	411
Program .....	414
Basic developmental projects.....	414
Linear surveys .....	414
Check-area establishment .....	416
Lake surveys .....	420
Zoological reconnaissance and collecting.....	424
Botanical reconnaissance .....	425
Reference collection .....	426
Phenological data .....	427
Exclosures .....	428
Natural area .....	429

Research and investigations.....	430
Linnology .....	430
Dwarf sucker study.....	435
Ruffed grouse study.....	436
Distributional study of small mammals.....	438
Clearings and plantings.....	439
White-tailed deer study .....	443
Live trapping and marking.....	445
Status of various vertebrate species.....	447
Graduate research projects.....	456
List of references.....	459

### FOUNDING—NEW YORK STATE COLLEGE OF FORESTRY

The New York State College of Forestry was established by a Legislative Act signed by Governor John A. Dix on July 28, 1911. The terms of the Act as set forth in the Charter are such that the College has authority to give instruction in Forestry and in addition to practice the science of forestry and to conduct research and investigation in that field. The term "Forests" (or Forestry) has a broader concept than the average layman appreciates. This concept of forestry includes not only trees, but in addition the organisms that are associated with them, whether or not these have any direct influence on the trees. It has been ably expressed by Dean Henry S. Graves of the Yale Forestry School (Graves '15, p. 236) "Forests are more than trees. They are rather land areas on which are associated various forms of plant and animal life. The forester must deal with all. Wildlife is as essentially and legitimately an object of his care as are water, wood and forage."

The College accepted this interpretation of forestry from the very beginning. This is attested by the fact that courses in Forest Zoology were included in its first curriculum and by the fact that the College, first through its Department of Forest Zoology and later through the Roosevelt Wildlife Forest Experiment Station, has been actively engaged in research on and investigation of forest wildlife, particularly where some important problem was involved or where a definite service could be rendered the public.

This phase of forestry has had wider recognition in the past ten years so that most of the forestry schools in the United States now give instruction and conduct research in wildlife management. Some European countries attach more significance to game management in

formulating their curricula than did forestry schools in this country.

The foregoing statements have been included in this part of the bulletin to orient the reader. It has been found that the public frequently does not know that the Roosevelt Wildlife Forest Experiment Station is a Department of the New York State College of Forestry at Syracuse University and that the Huntington Wildlife Forest Station of 15,000 acres in the Adirondacks is its field laboratory.

## FOUNDING—ROOSEVELT WILDLIFE FOREST EXPERIMENT STATION

**Organization.** The Roosevelt Wildlife Forest Experiment Station was authorized by the Legislature in May, 1919. It has the unique distinction of being the only Roosevelt Memorial adapted from plans bearing Theodore Roosevelt's personal approval. These plans were formulated by the first Director of the Station, Dr. Charles C. Adams, and were presented to Colonel Roosevelt in December, 1916. He urged that they be developed in a "big way" and began active work on them. While the entrance of this country in the first world war made it necessary to abandon temporarily the plans, the death of Theodore Roosevelt after the armistice gave added impetus to the idea and stimulated the Trustees of the College to request immediate action from the Legislature.

The law establishing the Station reads as follows: "To establish and conduct an experiment Station to be known as 'Roosevelt Wildlife Forest Experiment Station' in which there shall be maintained records of the results of the experiments and investigations made and research work accomplished; also a library of works, publications, papers and data having to do with wild life together with means for practical illustration and demonstration, which library shall, at all reasonable hours, be open to the public."

**Purposes.** The basic reason for the establishment of the Station has been summarized clearly by Adams ('21) "The appropriateness of the memorial has been confirmed by a number of close friends and admirers of Roosevelt who had worked with him for many years in his campaigns for conservation. It is especially fitting that the Station should be located at the New York State College of Forestry at Syracuse because the College emphasizes modern forestry, which consists in using forest regions to the best human advantage. This includes not only the timber, but the fish and game which can be used

for food and recreation, and any other crops, such as forage for grazing animals, and even a harvest of furs." Much of the work included under the provisions of the Legislative Act establishing the Station would now be included under the term "wildlife management", or "game management", which in final analysis is concerned with problems dealing with environments.

As mentioned above, Dr. Charles C. Adams was the first Director of the Station. He was a very energetic and enthusiastic leader and these characteristics were reflected in a large measure in the progress made by the Station from the very beginning. Dr. Adams resigned in May, 1926, to become Director of the New York State Museum and Dr. Charles E. Johnson who was Assistant Professor of Forest Zoology at the College, became the new Director of the Station. Dr. Johnson served until he died in June, 1936. W. A. Dence, the Assistant Director of the Station (appointed in July, 1927) was immediately made Acting Director to serve until the vacancy could be filled. This occurred in April, 1937, when the present Director, R. T. King was appointed.

**Activities and Accomplishments.** Previous to the establishment of the Roosevelt Wildlife Forest Experiment Station the Department of Forest Zoology at the New York State College of Forestry had done considerable biological work in the State, particularly at Oneida Lake and in the Palisades Interstate Park. Some of these projects were incomplete and the results of others had not been published when the Station was organized. The Station not only assumed the responsibility of carrying on where the Department left off, but in addition began a series of new studies.

Certain projects were undertaken in cooperation with other agencies or interests that were in a position to render aid in a material or financial way. The Station in these instances merely supplied the trained personnel and the field equipment.

The first project set up by the newly established Station was the Fish Survey of Erie County carried on in cooperation with the Erie County Society for the Protection of Birds, Fish and Game; the Buffalo Society of Natural Sciences; and several local sportsmen's associations. Part of the field work was done in 1920 but a considerable amount carried over into the following year. Sufficient data were gathered from each stream and pond in the county to warrant the issuance of definite recommendations immediately applicable to each unit (Hankinson, '24).

Several new projects were started in 1921. The Commissioners of the newly established Allegany State Park through their chairman, Senator A. T. Fancher, requested "A Survey of the conditions of wildlife" in the park (Adams, '21) and made a cooperative agreement with the Station for conducting the work. A field ornithologist devoted the entire summer to the birds and an ichthyologist with his assistant made a reconnaissance of the fish and the water courses with special reference to the native brook trout.

The results of these studies have been published in the Roosevelt Wildlife Bulletin (Saunders, '23, '26; Hankinson, '27; Kendall and Dence '27). The bird publications are written in a semi-popular style so that they might serve a two-fold purpose—as guides for park visitors interested in birds as a hobby and as references for those who wanted a more technical knowledge of the birds. The Kendall and Dence report on the trout survey of the park is unique in that it represents among other features a census of the trout population made by direct observation.

"An investigation of the status of the beaver problem in Herkimer and Hamilton counties of the Adirondacks, where the prolonged closed season on beaver had led to their excessive multiplication" was accomplished in 1921. This was possible only through the generous financial support of certain trustees of the College (Johnson, '22). The generosity of friends of the Roosevelt Station also made it possible to conduct wildlife research in the Yellowstone National Park in 1921. The food of the stream fishes as well as that of trout stream insects was studied by Dr. R. A. Muttkowski and Dr. Gilbert Smith (Muttkowski, '25, '29; Muttkowski and Smith, '29); the beaver by Edward R. Warren (Warren, '22, '26, '26a) and the larger mammals by Edmund Heller (Heller, '25).

All of the above projects were continued during the summer of 1922 and, in addition, a start was made on the trout survey of the Cranberry Lake region, which was instituted at the request of Commissioner MacDonald of the New York State Conservation Department, who had been besieged with requests from sportsmen for action to restore the original native brook trout productivity of the lake (Kendall and Dence '29).

Two new projects were started in 1923 as follows: Study of the birds in central New York marshes by A. A. Saunders and the muskrat in New York by Dr. Charles E. Johnson. The data on the marsh birds were published in 1926 as part of volume 3, number 3 of the Roosevelt Wildlife Bulletin. This report, illustrated with colored

plates, serves as a very useful guide for those interested in the denizens of our marsh areas. The publication on the muskrat (*Roosevelt Wildlife Bulletin*, volume 3, number 2) has been exceedingly popular and continues in demand by those who are interested in muskrat farming. It is interesting to note that the U. S. Biological Survey at one time referred all of its inquiries regarding publications on the muskrat to the Roosevelt Station.

A restudy of the beaver in the Adirondacks, following an open season, was made during the summer of 1924 by Dr. Charles E. Johnson (*Roosevelt Wildlife Bulletin*, volume 4, number 4). Studies were also begun on the white-tailed deer in the Adirondacks and on the diseases of the ruffed grouse.

The Roosevelt Station and the Harvard Forest at Petersham, Massachusetts, undertook a joint study of the red squirrel in 1925. Part of the field work was done in New York State, the balance at the Harvard Forest. Another study, dealing with the birds in the northern Adirondacks, was started the same summer. Both of these studies were continued and completed in 1926. The report on the red squirrel appears in volume 2, number 1 of the *Roosevelt Wildlife Annals*; that on the birds in volume 5, number 3 of the *Roosevelt Wildlife Bulletin*.

The Station's new field projects for 1926 were centered in southwestern Cattaraugus County, New York State, where studies were conducted on the wildlife and the forests of a 36,000-acre tract adjacent to the Allegany State Park. Similar studies were also conducted on the trout streams of the same area. Both reports are printed in volume 5, number 1 of the *Roosevelt Wildlife Bulletin*. Since the 1924 study on the white-tailed deer did not acquire sufficient worthwhile data to warrant publication of results new studies on that animal were instituted in 1927. Two biologists, Dr. M. T. Townsend and M. W. Smith, were engaged to conduct the study. Other new studies for the same year were as follows: (1) Study of the Biology of the Voles of New York State (*Roosevelt Wildlife Bulletin*, volume 5, number 4); (2) Biological Reconnaissance of the Peterboro Swamp and the Labrador Pond Areas (*Roosevelt Wildlife Bulletin*, volume 6, number 1); (3) The Fishes of the Tributary Waters of Oneida Lake.

In 1928, biological studies of the Oneida Lake region were resumed on a larger scale than had been the case previously. Dr. Dayton Stoner began an intensive study of the ornithology of the region (*Roosevelt Wildlife Annals*, volume 2, numbers 3 and 4) and Dr.

J. F. Mueller established the foundation for a comprehensive study of the fish parasites which was carried on as a joint project with Dr. H. J. Van Cleave during the succeeding three years (Roosevelt Wildlife Annals, volume 3). A start was also made on the study of the fishes of Cross Lake in the same drainage system.

There were so many unfinished projects in operation at the start of the 1929 season that only a single new one was possible. This one pertained to the life history and economics of the dusky skunk in central New York. Certain phases of this study have been published in the *Journal of Mammalogy* (Stegeman '30, pp. 493-496).

The Station did not escape the effects of the depression beginning in 1929, consequently certain phases of its biological work had to be curtailed. One new project, however, was set up in 1930 and continued over a period of several years. This project provided for a study of the small mammals of central New York—animals that serve a "buffer" rôle by providing food for certain predacious species and as a consequence relieve the strain on more desirable forms (Roosevelt Wildlife Annals, volume 4, number 1).

Dr. Stoner had amassed a considerable amount of data on the bank swallow during the study of the "Ornithology of Oneida Lake region". The large nesting colonies at the head of the lake offered an unusual opportunity for carrying on intensive studies with this species, consequently a project was set up in 1931 for that purpose (Roosevelt Wildlife Annals, volume 4, number 2).

Late in the summer of 1932 Mr. and Mrs. Archer M. Huntington deeded 13,000 acres of forested land in Hamilton and Essex counties of the Adirondacks to Syracuse University in trust for the New York State College of Forestry, to be known as the "Archer and Anna Huntington Wildlife Forest Station."

The acquisition of this field station made it necessary to alter the policy of the Roosevelt Station with respect to its wildlife studies. It provided an opportunity for carrying on intensive studies over a period of years with full assurance of no interruption from commercial or other interests. The acquisition of the property was particularly timely since scientists were just beginning to recognize and appreciate the need of control areas for obtaining data relative to certain phases of wildlife management. There was no abrupt change in the Station's activities, however, because it was considered unwise and wasteful to discontinue the various projects that had been started in previous years and which were still incomplete. Furthermore a considerable amount of reconnaissance work and physical develop-

ment was necessary before a definite program for biological work could be formulated. Steps toward that end were undertaken almost immediately and a preliminary reconnaissance of the Forest including an inventory of the vertebrate animals was started in 1932 and continued during the following two years. This first report on the Huntington Wildlife Forest Station was published in 1937 as volume 6, number 4 of the Roosevelt Wildlife Bulletin.

Only two new projects were started in addition to those on the Huntington Forest while these early plans were in the formulative stage. Dr. Murvel Garner began a limnological study of Cross Lake in 1935. This small lake has a diversified fish population and is highly productive. These qualities naturally make it a very popular place for sportsmen. The report is still in process of preparation. During the same year Dr. A. S. Hyde began a study of the birds along the northern boundary of New York State. The territory involved included the Thousand Islands region and the extensive beaches along Lake Ontario, both very popular summer resorts. The report (Roosevelt Wildlife Bulletin, volume 7, number 2) was prepared primarily for the benefit of the thousands of vacationists who frequent that region during the summer.

Beginning with the 1937 season the Roosevelt Station directed nearly all of its energies to the task of developing and putting into effect a long time research and developmental program on the Huntington Forest. The advantages of this area, for conducting research and experiments on wildlife in their natural surroundings, will become evident as one reads the balance of this publication.

**Present Policy and Program.** Dr. Charles C. Adams (1921), first Director of the Station, stated the duties of the then newly organized Roosevelt Wildlife Forest Experiment Station as follows: "The duties of the Roosevelt Wild Life Station are to investigate by all possible methods, our forest wild life: including the habits, life histories, methods of propagation and management of fish, birds, game, food and fur-bearing animals. The Station is thus primarily devoted to *increasing our knowledge* of forest wild life, by both outdoor and laboratory study which will develop new or improved methods of increasing the forest production of fish, fur and game animals and show their application to general forest management."

This account of "duties" was apparently a statement of Station policy. If so it might well serve as a statement of the Station's present policy. The Station today is still "primarily devoted to *increasing our knowledge* of forest wild life"; it is still attempting "to investigate

by all possible methods" including "both outdoor and laboratory study" this important forest resource; and it still seeks to "develop new or improved methods of increasing forest production" of this resource and "show their application to general forest management".

The changes that have occurred in the field of Forest Zoology in the more than twenty years since the Station was established have served to emphasize the importance of these points; and the knowledge that has accumulated during that time points to the need for more knowledge. In spite of all the work that has been done the problems today are even more numerous, more important and equally as difficult as they were twenty years ago. Additional values have been recognized and new uses developed; increasing demands are being made on the resource and on those charged with the responsibility of its conservation and management; and numerous new relations and interrelations have been discovered.

These changes have not only increased the scope and importance of Forest Zoology; they have also, to some extent, modified the course of its development and redirected its interest. In the light of these recent developments the Station policy has of necessity undergone some change.

Still other changes in emphasis are the result of an increase in Station facilities. The most important of these new facilities is the Huntington Wildlife Forest Station.

Due principally to these new interests in Forest Zoology and the new and increased facilities now available to the Station its policy has been revised and an almost entirely new program adopted. This new policy and program is based on the following concepts: The forest is a community, therefore forest wildlife research must take into account the entire forest community; the majority of forest areas are now and will continue to be subject to multiple use, therefore forest wildlife research must meet the needs created by these uses; there is immediate and pressing need for quantitative data, therefore our research must be directed toward meeting this need; and there are important problems that can be solved only through intensive study of all the factors on one area over long periods, therefore work on these problems should be undertaken by those agencies possessing the necessary facilities.

Various phases of the program are covered in detail in the following discussion of the Station's activities.

## THE HUNTINGTON FOREST

**Acquisition.** The Archer and Anna Huntington Wildlife Forest Station, held in trust by Syracuse University for the New York State College of Forestry, is a rectangular 15,000-acre tract of land and water in the central part of the Adirondacks west of the village of Newcomb, New York. The greater part of the tract (13,000 acres) was transferred to the University on July 30, 1932, the balance, known as the "Arbutus Preserve" on July 15, 1939. The Arbutus preserve provided "a headquarters site for the research staff that is less than one-half mile from the state highway and is easily accessible at all seasons of the year. Buildings and equipment transferred with the property are of definite value in connection with the forest program. The great generosity of the donors in these and other respects makes possible the full accomplishment of their objectives in the maintenance of continued research and the application of forest management with particular reference to wildlife" (Spring, '40).

By the provisions of the deed of trust, the Huntington Forest is for the use of the New York State College of Forestry, "for investigation, experiment and research in relation to the habits, life histories, methods of propagation and management of fish, birds, game, food and fur-bearing animals and as a forest of wildlife" (Johnson and Dence, '37).

**Personnel.** The first step in the development of the Huntington Forest was the hiring of a forester at the time of its acquisition in 1932. His duties were to protect the Forest from fire and trespass and, in addition, perform such work as was required by the College. Mr. O. W. Oja, a graduate of the College, was appointed to this position and provided with an assistant—Mr. Theodore Phillips, a graduate of the New York State Ranger School. Both men are still serving in these capacities and are, of course, in residence on the Forest the year around.

Prior to the summer of 1938, various members of the Roosevelt Station Staff visited the Forest at infrequent intervals while doing research or reconnaissance work with respect to the wildlife. Beginning with the summer of 1938 the entire regular staff with a number of student assistants has been on the Forest throughout the summer months and, in addition, on numerous occasions during the other seasons. The student assistants varied from four in 1938 to nine in 1941. Some of these students, however, were engaged in obtain-

ing data for theses as part of their graduate work for higher degrees and consequently were required to render only part-time service on College projects. A graduate student has been in residence throughout the winter months during each of the past two winters, and has carried on various phases of the Forest program.

**Description.** *Location.* The area included within the Archer and Anna Huntington Wildlife Forest Station is approximately seven miles long in greatest length and three miles wide, lying in a north-west-southeast direction. The main portion lies in Essex County and the remainder, or northwest portion, lies in Hamilton County. The Long Lake-North Creek highway crosses the southern portion of the Forest before entering the village of Newcomb which is located just off the southeast corner of the tract.

*Topography.* "Surrounded by the highest peaks of the Adirondacks on the north and northeast, and by only slightly lower mountains to the west, south, and east, the Forest has an average elevation of 1800 to 2000 feet above sea level, and a range of altitude from 1560 feet at Lake Belden to 2693 feet at the summit of Goodnow Mountain. Other than swamps and meadows relatively level areas are exceptional" (Heady, '40).

The topography of the approximately 5000 acres within the check-area has been very carefully mapped by the Roosevelt Station personnel and the resulting contour map appears in this bulletin (Map 4). The check-area includes Catlin, Panther, and Observation mountains and part of Moose Mountain—the most rugged portion of the Forest, exclusive of Goodnow Mountain which is the highest peak.

The five lakes (Arbutus, Catlin, Rich, Deer and Wolf) lying wholly within the confines of the boundary have a total area of 1290.5 acres; they range in size from 94.4 acres to 536 acres. There are several other large lakes only partially within the boundary, in addition.

*Climate.* Definite data concerning the temperatures, precipitation, winds and other meteorological phenomena of the Forest are not available prior to July 1, 1940. Since that date a weather station has been maintained in continuous operation at Arbutus Camp. This station is one of the cooperative units of the United States Weather Bureau established through its New York section at Ithaca, and listed in its publication "Climatological Data for the New York Section" as the Newcomb Station. Precipitation, amount of snowfall, maximum and minimum temperatures, wind direction and velocities, nebulosity, barometric pressure, and numerous other readings are taken

daily, most of them three times each day. Tables 14, 15, and 16 present the monthly summaries of some of these records for the year July 1, 1940 to June 30, 1941. There is no means of telling how near "average" conditions were during this year. It is obvious that the records will increase in value the longer they are continued.

TABLE 14. RECORD OF PRECIPITATION AND SNOWFALL AT THE NEWCOMB STATION.

MONTH	Precipitation Inches	SNOWFALL			Number of Days with .01 Inch or More of Precipitation
		Total Snow Inches	SNOW ON THE GROUND		
			15th of the Month	End of the Month	
July 1940.....	5.44				14
August “ .....	1.89				7
September “ .....	3.78				12
October “ .....	2.30				8
November “ .....	4.07	13.0	0.0	13.0	17
December “ .....	5.72	22.1	14.0	9.3	17
January 1941.....	3.38	23.8	15.5	23.0	16
February “ .....	2.04	14.7	26.0	26.5	10
March “ .....	3.27	29.2	35.8	26.8	13
April “ .....	2.42				6
May “ .....	2.10				10
June “ .....	1.82				12
Total.....	38.23	102.8			142

TABLE 15. TEMPERATURE RECORDS AT THE NEWCOMB STATION.

		Maximum	Mean Maximum	Minimum	Mean Minimum	Mean Temperature
July	1940.....	88	78.8	39	52.7	65.8
August	" .....	87	75.8	29	50.4	63.1
September	" .....	78	67.2	29	43.9	55.5
October	" .....	78	54.6	13	30.2	42.4
November	" .....	67	39.5	-8	25.0	32.3
December	" .....	41	30.5	-28	11.5	21.0
January	1941.....	35	23.7	-20	3.1	13.4
February	" .....	41	26.9	-15	5.6	16.3
March	" .....	48	33.2	-15	9.9	21.5
April	" .....	85	60.4	16	30.6	45.5
May	" .....	88	70.1	25	40.2	55.1
June	" .....	93	77.4	35	50.5	63.9

TABLE 16. NEBULOSITY AND WIND DIRECTION AS RECORDED AT THE NEWCOMB STATION.

		NUMBER OF DAYS			Direction of Prevailing Wind
		Clear	Partly Cloudy	Cloudy	
July	1940.....	6	15	10	west
August	" .....	14	8	9	north-west
September	" .....	8	9	13	north-west
October	" .....	11	10	10	north
November	" .....	4	3	23	north
December	" .....	6	4	21	north
January	1941.....	7	7	17	north
February	" .....	10	3	15	north
March	" .....	8	7	16	north
April	" .....	12	12	6	east
May	" .....	11	12	8	north
June	" .....	9	12	9	north
Total.....		106	102	157	

*Geology.* "The entire Adirondack region has been subjected to many complex changes, including marine deposition, folding, uplift, peneplaining, igneous activity, faulting and glaciation. The rocks, because of these complexities, include metamorphic sediments, gneisses, quartzites, and crystalline limestones. All of these formations have been subjected to tremendous pressures which have folded and thoroughly metamorphosed them. The oldest of the rocks belong to the Grenville formation, a metamorphosed series of folded sedimentary rocks composed of marbles with imbedded quartzites and schists.

"The major portion of the Huntington Forest, which includes the mountainous parts, is underlain by resistant syenite and granitic material. Many of the other areas of softer, more easily eroded marbles have been worn away to form depressions, for example, Newcomb Valley. A few valleys, however, follow fault lines or cross joints.

"Glaciation has changed the surface features very slightly, having only a smoothing effect on the general topography. Many lakes, of which Wolf Pond is an example, have been formed by morainal damming of valleys. Glacial till, varying in thickness from a few inches on the hillsides to probably not more than 100 feet in the valleys, covers quite completely the underlying formations. Cushing ('07) reports morainic deposits in considerable quantities around Corner Pond and on the east and west slopes facing Catlin Lake. Balk ('32) reports another deposit along the north shore of Rich Lake" (Heady '41).

A geological survey of the Forest area is in progress.

*Vegetation.* Heady ('40) reported seven hundred and sixty-one species of ferns and flowering plants from the Forest area and its near vicinity. Collections of those species actually found on the Forest have been prepared and filed with pertinent data in the Forest museum. Lowe ('40) has studied the lichens and Smith ('40) the fungi. Work will eventually be done on the mosses and algae. In fact, these have already been studied to a certain extent.

For a complete description of the vegetation of the Forest see Heady ('40).

## PHYSICAL DEVELOPMENTS ON THE HUNTINGTON FOREST

A Civilian Conservation Corps camp has been located on the Forest continuously since 1933. Although the camp is located on Forest property its work program has been about equally apportioned to Federal, State and Forest projects. Each year during the eight years

of the camp's existence its annual work programs have included many projects pertaining to the development of the Forest. Without the aid of this agency, and the fullest cooperation from the State and Federal departments responsible for its administration, it would have been impossible to accomplish or even undertake any large share of the projects relating to the physical development of the Forest.

**Truck Trail.** The largest of the CCC projects and the first one undertaken was the construction of the truck trail. When the property was acquired the only existing road was the short stretch (about a mile in length) from the State highway to the site of the present ranger headquarters. Since then approximately ten miles of high-grade truck trail have been completed. The main portion, seven and one-half miles in length, extends from Fishing Brook bridge, just north of the State highway, to Wolf Lake cabin. It will eventually be extended to join with that portion first completed near its point of origin, and thus complete a loop through the Forest. About two miles of additional trail are needed to accomplish this purpose since slightly more than two miles were built from the opposite direction during the last two years. This last-mentioned stretch extends from a point just north of Fishing Brook bridge across Military Lake outlet to a point just beyond the middle portion of Military Lake. About one-half mile of a spur from the main truck trail leading to the north boundary by way of Deer Lake cabin has been completed, as has also an additional one-fourth mile extending from the ranger headquarters to the Arbutus Camp on the east shore of Arbutus Lake.

The policy of the College with respect to truck trails is to limit construction to that amount necessary for making the various parts of the Forest accessible without too great an expenditure of time and effort. Accessibility is essential both for productive research and effective and economical patrol.

**Foot Trails.** An extensive system of foot trails existed on the Forest at the time of its acquisition and, despite their condition and location, rendered useful service by making the various parts of the tract accessible on foot. In fact, except for the lakes and the State highway, travel within the Forest was then largely restricted to foot trails. Most of these foot trails were maintained from the outset; some have been abandoned recently because the check-area lines and the truck trails have proven more convenient for the purposes they served. However, about twenty-five miles of foot trails are still maintained as a means of reaching more remote parts of the tract, and for convenience in conducting wildlife studies.



Fig. 78. Type of bridge used on truck trail.



Fig. 79. Concrete dam at outlet of Military Lake, constructed in 1940.

The CCC has improved several miles of the more frequently used foot trails by brushing and clearing fallen trees and by the construction of foot bridges across the larger streams and swamps.

All of the trails are being accurately measured and provided with permanent distance markers at 10-chain intervals for convenience in recording observations on wildlife. The markers are mounted on metal posts and are distinctive in pattern and color.

**Buildings.** The problem of providing living quarters and laboratories for the Huntington Forest personnel has been difficult from the start.

The building program is now well under way. Living quarters, including a log cabin with a two-car basement garage, and several out buildings including a woodshed, ice house and boathouse, were constructed with WPA labor in 1935-1936 for Forest Supervisor Oja near the main highway on the south shore of Rich Lake. The ranger's headquarters at the south end of Arbutus Lake, similar in most respects to supervisor's headquarters, was completed in 1940.

The buildings on Catlin Lake occupied by Mr. Oja prior to completion of his new residence were slightly remodeled in 1938 to accommodate three families of the staff and two graduate students while conducting field work that summer. These were also used for housing the staff while taking censuses and making other studies during two following winters. They were no longer needed after the Arbutus Preserve was acquired and, except for one small cabin, have been dismantled.

Two small single-room log cabins, one on Wolf Lake and the other on Deer Lake, were constructed with CCC labor during 1937 and 1938 for the purpose of providing overnight shelter for those assigned to work in these localities. Both cabins have been used for housing families of the staff during the summers.

In 1939 one of the buildings at the Arbutus Camp was remodeled to serve as a dormitory for students during the summer months and for both students and staff during their monthly trips to the Forest at other seasons.

Since the Arbutus Camp has been selected as permanent headquarters, because of its central location and accessibility, a number of buildings used as temporary living quarters are being dismantled by the CCC and made into smaller and more suitable permanent quarters. Three new residences for the staff are already underway, one of them nearing completion.

A concrete building, partially completed by Mr. Huntington, has been made into a fireproof museum for housing records, specimens, charts, blueprints and valuable equipment. Laboratories, a garage, and other smaller buildings are to be built later.

**Telephone Line.** There are about fifteen miles of private telephone line on the Forest in addition to outside lines to the living quarters of Supervisor O. W. Oja and Ranger T. R. Phillips. Telephones have been installed at Catlin Lake Camp, Catlin Lake boat-house, Wolf Lake cabin, the Forest Supervisor's quarters, the Forest Ranger's quarters and Arbutus Camp. One will be installed at Deer Pond Camp on completion of the truck trail to this camp.

**Dams.** A series of three artificial lakes was created prior to 1920 in the stream valley extending from the head of Rich Lake north towards Wolf Lake. The dams were of the earth-fill crib type, and as they had not been maintained or repaired for several years they were in a bad state of repair when the property was acquired by the College.

A project in the 1939 CCC plan called for the replacement of these earth-fill dams with concrete structures, each provided with a sluice gate of sufficient size to permit draining of its respective lake within a 24-hour period—the sluices to be adequately equipped with screens to prevent the escape of fish.

The lowermost and second largest of these dams was constructed during the summer of 1940 and is now in operation. The completed dam is 320 feet long and inundates about 18 acres of land to a maximum depth of 7 feet. It is too warm for native trout, but is ideal for certain species of waterfowl and a few species of game fish.

The larger of the two dams to be built on the other sites will impound water of sufficient depth to maintain proper temperatures for native trout.

**Miscellaneous physical developments.** Other major physical developments include the erection of power lines from the Long Lake-Newcomb commercial line into the Arbutus Camp, and the Supervisor's and Ranger's headquarters; the provisions of a well, storage reservoir and pumping system at Arbutus Camp; the construction of numerous docks; the resurvey of the 22.5 miles of forest boundary; and the posting and establishment of distance markers on the boundaries.

## ROOSEVELT STATION PROGRAM

**Policy.** As stated earlier the research activities of the Station are almost wholly confined to the Huntington Forest. As a consequence the policy in effect on the Forest is the policy governing the Station.

The Forest policy is well stated in the deed of trust executed by Mr. and Mrs. Huntington when the property was made available for College use. This deed states that the tract is for the use of the New York State College of Forestry "for investigation, experiment and research in relation to the habits, life histories, methods of (natural) propagation and management of fish, birds, game, food and fur-bearing animals (mammals) and as a forest of wildlife". The covenant of the deed further provides there shall be no shooting of birds or other animals or catching or killing of fish permitted except for such purposes as may be deemed necessary or desirable for the furtherance of the object of the conveyance.

**Purposes.** The purposes of the Forest, in compliance with the policy as stated above, are:

*Investigation.* To study over a long period of years at all seasons of the year and under all conditions all of the aspects of the Forest—plants, animals, soils, water resources, etc.—under as nearly natural conditions as can be maintained.

*Experimentation.* To conduct controlled experiments on all aspects of the Forest and check the results obtained against the results obtained from investigations under natural conditions.

*Demonstration.* To demonstrate on the ground the various methods of planting, clearing, logging, pruning, etc., that are found to be best adapted to the region and most beneficial from the point-of-view of the entire forest community—plants, animals, soils, water resources and those human agencies and communities dependent upon or interested in the resources of our forests.

*Publication.* The publication of results obtained from investigation and experimentation and descriptions of techniques devised in connection with the work.

*Teaching.* The training of students in both the research and management phases of the work by actual participation in its various phases.



Fig. 80. Aerial photograph showing southern half of Deer Lake, several beaver dams and ponds along Deer Creek (upper right), section of truck trail (lower left), and beaver pond and meadow along Wolf Creek (left center). May 10, 1941.



Fig. 81. Aerial photograph showing entrance road (at extreme lower left), truck trail routes (Catlin Lake at left, Arbutus Lake headquarters in middle and Lake Adjidaumo at bottom and extreme right), Military Lake and its new concrete dam (right of center at bottom), and some of the newly made clearings.

**Program.** The program of investigation on the Huntington Forest is based on the belief that the problems confronting wildlife and forest managers are to a considerable extent biological problems, and that carefully conducted research is the only basis upon which sound wildlife and forest management and conservation can be built. Because of the nature of the problems involved much of this research must be carried on over a long period of years.

The work on the Huntington Forest involves first, the development of the Forest as a wildlife station and second, the inauguration and prosecution of those researches which properly constitute the program of such a station. Ideally the developmental work should precede the research work. It has not been possible to follow this ideal arrangement on the Huntington Forest; as a consequence the two phases of the work are being carried on concurrently.

The various phases of the program in effect on the Forest are graphically presented in Figure 100, and discussed in detail in the latter part of this bulletin. Reference to this five-step program will show clearly the objectives of our work on the Forest and the manner in which the work is being conducted.

## BASIC DEVELOPMENTAL PROJECTS

**Linear Surveys.** *Aerial Survey of the Forest.* Aerial photographs were taken of the Forest on May 10, 1941, by Mr. U. P. Harvell of the Syracuse Camera Shop from a 275 horsepower Stinson biplane piloted by Mr. Panella of the Utica Aviation School.

A total of 96 exposures 13 cm. by 18 cm. in size were taken with a Zeiss aerotopographic camera having a 184 mm. focal length. The photographs were taken by making four successive trips lengthwise of the tract, allowing about 60 percent overlap on each exposure to insure proper joining in the formation of the "mosaic" map. The plane travelled at approximately 9,200 feet above sea level. Two sections of this map have been used as illustrations in this bulletin (Figs. 80 and 81).

The date selected for taking the photographs was the first one on which weather conditions were favorable following the period when the greatest contrast in the color of the new forest foliage within various types was perceptible. The contrast in color was considered advantageous in segregating the various forest types on the photographic prints.

Considerable preliminary work was done on the ground before the biplane arrived. This consisted in marking each corner of the Forest

as well as numerous other locations with lime. These marks appear as small specks on the photographs, but nevertheless are sufficiently large to fulfill the intended purpose.

A certain amount of "ground control" will be done this fall to determine elevations of certain points, and then stereoscopic equipment can be used to prepare the topographic map of the Forest.

*Topographic mapping.* United States Geological Survey topographic maps are available for the entire Huntington Forest and are extremely useful for certain purposes, but are unsuitable for use in connection with intensive studies such as those that are being conducted on the check-area. There was an obvious need for a topographic map of the check-area—one based on accurate measurements and drawn on a scale of sufficient size to show minute details in the topography. The long-time program in effect on the check-area is sufficient justification for the cost of preparing such a map.

Some of the data for the map were obtained during the summer of 1939, the balance the following summer. The field work was done by crews of two men. Each crew was equipped with a two-chain steel tape with trailer and each man carried an Abney hand level. The chain was used in making accurate measurements of all distances while the Abney hand levels were used by the two men for taking simultaneous readings from the two ends of the tape to determine the changes in elevation for that distance. The use of the two levels gave a check on the setting and reading of the instruments thus eliminating the possibility of error.

The check-area was mapped by using each 40-acre block as a separate unit. The boundaries and three evenly spaced lines five chains apart extending parallel with the north-south boundaries of each block were run with tape and levels.

Both members of the crew recorded distances, Abney level readings, changes of elevation and elevation above sea level. One man had the additional task of sketching the contours on a field map as the work progressed. All elevations above sea level were reckoned from a bench mark established by the United States Geological Survey on a large boulder on the west shore of Catlin Lake.

The field data have been transferred to a map of the check-area prepared on a scale of sixteen inches to the mile, with contour intervals of ten feet. This map has been reproduced and appears as part of this bulletin (Map 4).

A relief model of this map is partially completed.

*Floristic mapping.* Knowledge of the distribution and abundance

of certain plant species is basic to an interpretation of the distribution and abundance of animal species in a forested area. Plants provide food and cover either directly or indirectly for all animal species. Probably no two species require exactly the same kinds of food and coverts; most species have different requirements at different seasons; the two sexes often utilize different foods and coverts; and in most cases, young animals do not have the same requirements as the adults. For these reasons, considerable time has been spent in determining the distribution and abundance of the plant species which fulfill these requirements on the Huntington Forest.

A portion of the summer of 1939 was devoted to devising and testing techniques that could be used to accomplish the desired results. While several hundred acres of the check-area were mapped in 1939, the remaining plots were done in 1940. Several crews were used toward the end of the 1940 season to insure completion of the project before heavy frosts arrived. It should be understood that the method of mapping and the results were intended for wildlife management purposes and as such may not be applicable to general forestry practices.

The method used for studying the distribution and abundance of the various plant species has been described by Webb ('42). This method involves the sampling of the vegetation at 75 stations on each 40-acre block.

The tree species on a plot 66 feet in radius were recorded at each station. The size of these trees and their density (on a relative scale, i.e., trace—less than  $1/80$  of the area of the plot covered; density 1—between  $1/80$  and  $1/3$  of the area of the plot covered; density 2—between  $1/3$  and  $2/3$  of the area of the plot covered; and density 3—between  $2/3$  and  $3/3$  of the area of the plot covered) was also recorded. The woody shrubs and the tree species less than 3 feet in height were recorded with their relative density on a plot 3 yards square. The ground cover species and their relative density were likewise recorded on a plot one yard square.

These data have been compiled in tabular form and will be used to determine the relationship between the distribution of animal species and the flora on which they are dependent. Preparation of the maps for the various plant species is now in progress.

**Check-Area Establishment.** Director King of the Roosevelt Wildlife Forest Experiment Station made the following recommendation in his 1936-1937 report to Dean Spring who in turn transmitted it to the Board of Trustees of the College (See N. Y. State

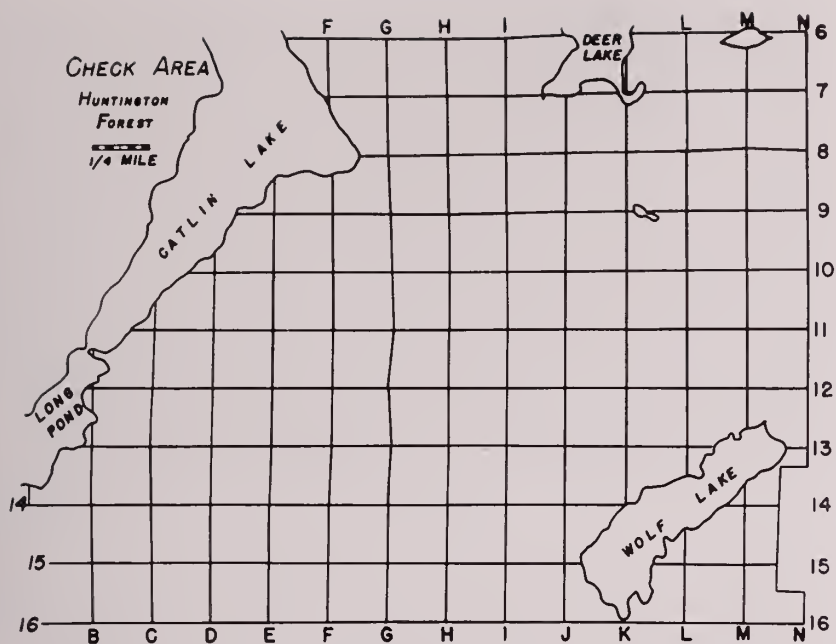


Fig. 82. The check-area. Its location with respect to the rest of the Forest can be seen by consulting map at the back of this bulletin.

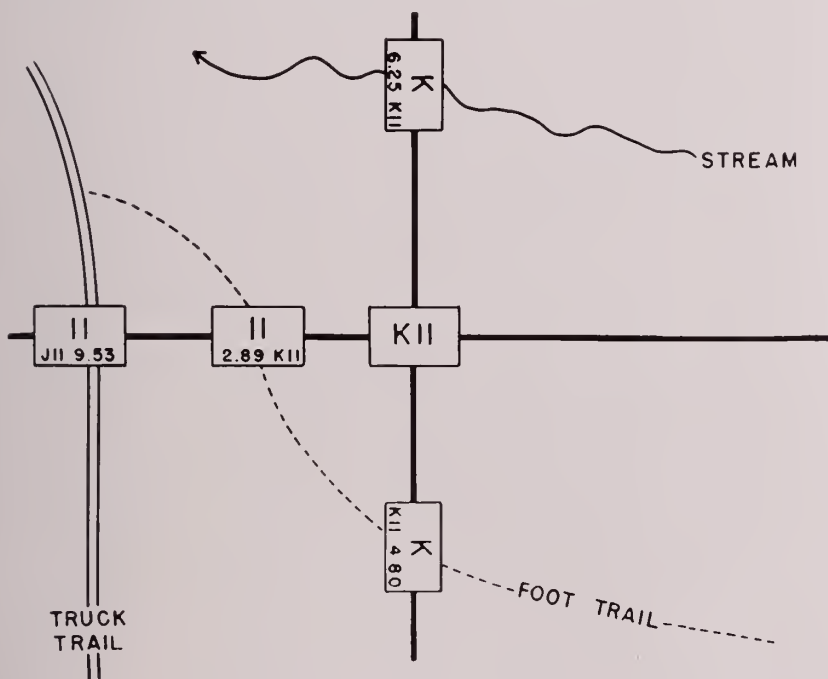


Fig. 83. Sketch to show system of placing signs on the check-area.



Fig. 84. The forest undergrowth provides much needed cover for deer in stormy weather.



Fig. 85. The check-area lines are practically obliterated in the winter and would be difficult to follow if it were not for the orange-colored rings on the trees. The line in the photograph passes between the snowshoes.

College of Forestry Bulletin 20, volume 10, number 3-b, 1937, p. 50). "The first and most important piece of work to be carried on at the Huntington Forest is the establishment of a check-area. This area should be not less than 5000 acres in extent, approximately three miles long, not less than two miles wide. The best location is at the east end of Catlin Lake, between Wolf Lake, Deer Pond and Arbutus Lake preserve. Its exact location should be determined this summer [1937]. Its boundaries conspicuously marked and lines bounding each 40-acre tract run across the area from east to west and north to south and permanently marked. The area should then be completely and carefully mapped." The recommendation was approved and the final plans for the establishment of the check-area were formulated, making it possible to begin actual work early in the spring of 1938.

The site mentioned was practically the only place on the Forest where it was possible to take a single block of the required area, dimensions, and diversification of habitat and terrain. It included high mountains, lowland, lakes and streams, beaver meadows, burned areas, clearings, and representative forest types. Some of these environments were especially good for wildlife, others were very poor and there were various intermediates. In general, the area was a good cross-section of the entire Forest and to a certain degree the entire Adirondacks region.

One of the objectives during the establishment of the check-area was to maintain natural conditions as much as possible. Only a small portion of the area touches the Forest boundary because in planning the project it was felt that a buffer zone was desirable between the check-area and the adjacent private property. A few roads and trails were necessary to make it more accessible to the biologists engaged in research on the area but these were kept to a minimum. No new trails were established and some of the existing old trails were abandoned. A truck trail had been constructed through the area and while it is almost indispensable it does create artificial conditions. Various parts of the check-area are made accessible by the grid lines that extend north-south and east-west at  $\frac{1}{4}$ -mile intervals. These lines were brushed and cleared, but evidence of this clearing was soon obliterated and were it not for painted markers along the lines it would be almost impossible to distinguish the lines from the adjacent areas during the winter.

Most of the check-area was completed during the summer of 1938 so that it was possible to begin using the area in October of that year. All surveying work was started from the so-called "base line" in establishing the check-area. This base line which extends from the

north boundary of the Forest to the south boundary was established in 1937 in connection with another survey project. That portion which falls within the confines of the check-area is known as the "I" line. Control lines were run from this line with the use of a transit and steel tape to enclose traverses. More than twenty-one miles of transit line were run for that purpose. The remainder of the check-area lines was run as "picket lines". These were merely a continuation of the transit lines with a series of pickets, or sharpened stakes, driven into the ground and put in position by backsighting over the line. If the picket line failed to meet its intended point the difference was corrected by making a proportionate allowance and resetting the pickets at each two-chain interval.

The junction of each of the check-area lines has been marked with a four-foot iron pipe bearing a sign which gives the letter of the north-south line and the number of the east-west line, for example "F8". Whenever a line crossed or reached certain land marks such as a stream, foot trail, truck trail, or lake shore a sign of the type previously mentioned, stating the number or letter of the line and the direction and distances to the nearest corner, was used (See Fig. 83).

Orange has been selected as the standard paint color for the check-area. This has been used on the signs and, in addition, in making 3-inch rings around numerous trees along the line. These rings are placed about six feet above ground. They not only make it possible to follow the lines without difficulty, even in the winter, but assist in locating the lines when studies are in progress within the various blocks. Orange has advantages over other colors due to its conspicuousness at all seasons, its non-fading tendencies and its covering qualities.

**Lake Surveys.** The morphometry of the larger lakes on the Huntington Forest has been determined by lake survey work done during the winters of 1938, 1939, and 1941. The field work was done under the supervision of the staff of the Roosevelt Station with the help of the CCC camp located on the Forest. The plotting of the maps was done by the Roosevelt Station staff.

The purpose of these surveys was to determine the area of the various lakes in their entirety and within certain depth limitations, their shape and the configuration and the type of bottom. All of these data were basic to the limnological studies that were made during the succeeding years. In fact they were basic to and necessary for the forthcoming work on the limnological aspects such as thermal stratification, free oxygen content and free and fixed carbon-dioxide

content of the water, aquatic plant zones and a number of other factors.

The contour maps (Fig. 86) that were constructed from the data already have proven of inestimable value and are constantly in demand by those engaged in work on the Forest. The number and location of field stations for all of the limnological studies have been determined directly from the lake contour maps. These are so accurate that no difficulty arises in locating the sites for the station markers. The maps eliminate much reconnaissance work so that the time element alone compensates for the cost of making the surveys.

The lake surveys were conducted during the winter after the ice had reached a thickness of 12-20 inches. Teaching duties made it impossible to release the personnel for the work earlier in the season when the ice was thinner and thus easier to penetrate. The task of cutting holes through the ice for soundings was relegated to CCC labor. This alone was a considerable job because approximately 2000 holes were necessary for Catlin Lake and a correspondingly smaller number for the smaller lakes.

The survey on each lake was started by establishing a base line along the long axis which was marked with pickets at two-chain intervals (132 feet) in the center of the lake, at one-chain intervals (66 feet) closer to shore and at  $\frac{1}{2}$ -chain intervals near shore. Lines were run at right angles from these picket stations to the shores and additional stations were established at two-chain, one-chain, or one-half chain intervals as in the case of the base line. A transit was used in establishing the base line, in turning all angles for the cross lines and in running all lines. The distances were measured with a steel tape.

Soundings were made at each of the stations along the various grid lines; the necessary holes started with an axe and completed with a sharp "spud" of the type used by ice fishermen. The soundings and the bottom samples were taken simultaneously with the same piece of apparatus. This was a "home-made" affair—simply a 3-foot piece of  $2\frac{1}{2}$ -inch galvanized iron pipe with a clamshell-like arrangement at the lower end to prevent the sample from escaping until released at the surface. It proved to be very efficient.

Maps showing the location and extent of the various types of bottom have been prepared from the data in addition to the usual contour maps. Various land marks adjacent to the shores are also indicated on the maps.

The following table gives a résumé of the lake survey work.



TABLE 17. SHOWING DATA ON LAKE SURVEY PROJECT.

LAKE	Area (Acres)	Man-days by Roosevelt Staff	Man-days by CCC	Number of Soundings
Arbutus.....	120.8	5	69	490
Catlin.....	536.1	33	360	2,026
Deer.....	94.4	10	53	311
Military.....	18.0	2	30	111
Rich.....	395.9	26	251	1,607
Wolf .....	143.7	18	89	441
Total.....	1,308.9	94	852	4,986

The total areas within certain contours have been determined with a planimeter for all the lakes. They are as follows:

#### *Arbutus Lake*

Total area of lake.....	120.8 acres
Area between shore and 2½-foot depth.....	18.2 acres
Area between 2- and 5-foot contours .....	22.8 acres
Area between 4- and 9-foot contours .....	30.1 acres
Area more than 5 feet deep .....	84.4 acres
Area more than 10 feet deep.....	55.9 acres

#### *Catlin Lake*

Total area of lake .....	536.1 acres
Area between shore and 2½-foot contour... ..	37.7 acres
Area between 2- and 5-foot contours .....	45.2 acres
Area between 4- and 9-foot contours.....	186.1 acres
Area more than 5 feet deep.....	460.8 acres
Area more than 10 feet deep.....	293.2 acres

#### *Deer Pond*

Total area of lake.....	94.4 acres
Area between shore and 2½-foot contour... ..	14.8 acres
Area between 2- and 5-foot contours.....	25.3 acres
Area between 4- and 9-foot contours.....	28.6 acres
Area more than 5 feet deep.....	58.7 acres

#### *Rich Lake*

Total area of lake.....	395.9 acres
Area between shore and 2½-foot contour.....	25.9 acres
Area between 2- and 5-foot contours.....	31.0 acres
Area between 4- and 9-foot contours.....	45.8 acres
Area more than 5 feet deep.....	344.2 acres
Area more than 10 feet deep.....	299.8 acres

*Wolf Lake*

Total area of lake.....	143.74 acres
Area between shore and 2½-foot contour.....	10.4 acres
Area between 2- and 5-foot contours.....	12.5 acres
Area between 4- and 9-foot contours.....	13.3 acres
Area more than 5 feet deep .....	122.9 acres
Area more than 10 feet deep.....	108.4 acres

**Zoological Reconnaissance and Collecting.** The first study on the Huntington Forest consisted in making a reconnaissance of the vertebrate animals and their habitats. This study was started almost immediately after the property was acquired and was for the express purpose of acquiring basic knowledge that could be used in formulating future research programs. The bulk of the field work was done during the summers of 1933 and 1934 and the resulting report appeared in 1937 (Johnson and Dence). This report lists the following numbers of species from the forest area:

Fish .....	20 species
Amphibians .....	13 species
Reptiles .....	2 species
Birds .....	97 species
Mammals .....	31 species

The list has been increased slightly since the publication of the report by the following additions:

Fish .....	4 species
Reptiles .....	2 species
Birds .....	8 species
Mammals .....	2 species

It is reasonable to expect further additions as time goes on because the staff will be larger and some members will be on the Forest at all seasons of the year.

A considerable amount of collecting was done in connection with the above-mentioned reconnaissance work. It was the policy, however, to collect only those specimens that were absolutely necessary to determine representative species. These collections were properly preserved or mounted and will soon become part of the Forest museum. Salvage specimens are being added to the collection at every opportunity, but additional species will have to be collected if the museum fulfills its intended purpose. Many of these species will soon be added to the collection through the efforts of a student assistant trained in taxidermy and employed for the summer.

The invertebrate species have been given very little attention to date, but they are scheduled to take a more prominent place on the program in the near future. The staff recognizes the invertebrates as a very significant part of the wildlife of the Forest and consequently feels the need of having a reference collection of the various species in the museum. Many invertebrate species will be obtained in connection with the limnological studies and others will be acquired as parasites of the vertebrates.

Pertinent data are required for each specimen, both vertebrate and invertebrate, included in the museum collections. Poorly mounted or improperly preserved specimens likewise are barred from the reference collection.

**Botanical Reconnaissance.** Practically every wildlife problem undertaken on the Huntington Forest, as elsewhere, is connected in some manner with the local flora, therefore if the biologist concerned does not know the plants a means should be provided to that end. This would not be a difficult problem if the Station maintained a resident botanist at all times. Since this is not always possible the Station has adopted the plan of making a complete botanical reconnaissance and at the same time preparing a reference collection of all the species. Furthermore, as explained on page 427 a floral register will be available for consultation and will have special value for those who know plant taxonomy in a general way, but are not familiar with the technical nomenclature.

Preliminary work on the flora was begun during the summer of 1934 at which time Dr. J. L. Lowe, instructor in the Department of Forest Botany, at the New York State College of Forestry made extensive collections of lichens and Dr. Alexander H. Smith of the University of Michigan Herbarium collected and studied certain groups of the fungi. The preliminary reports on these studies have been published in volume 7, number 3 of the Roosevelt Wildlife Bulletin.

A project dealing with a systematic study of the ferns and flowering plants was inaugurated in the spring of 1938. Mr. Earl Stone, a graduate student majoring in botany, collected very extensively through that summer. Mr. Harold Heady, then graduate assistant in the Department of Forest Botany at the College, resumed work on the project late that fall and the following winter, but did not devote his entire time to the study until June, 1939. His annotated list, prepared as partial fulfillment for a Master of Science degree, has been published in volume 7, number 3 of the Roosevelt Wildlife

Bulletin. Mr. Heady lists a total of 328 genera and 761 species, although some of these were found on adjacent territory by Dr. H. D. House of the New York State Museum who has been collecting in the Newcomb region for several years. Dr. House very generously gave the Station the data on plant species that he found near the Forest and these have been listed because it is quite likely that they will eventually be discovered on the Forest. Relatively few additional species have been discovered since the completion of the original study.

Representative specimens of all the species collected have been filed in the Museum at the Huntington Forest for future reference. Similar sets have been deposited in the New York State Museum and in the Herbarium of the New York State College of Forestry.

During the summer of 1940, additional work was done on the gross aquatic vegetation of all the waters on the Forest. Sufficient data were acquired to make it possible to construct charts that show the kinds, amounts, location and distribution of all aquatic flora.

These charts will be very useful, particularly to those working on fish and waterfowl.

**Reference Collection.** It has been the established policy of the Roosevelt Wildlife Forest Experiment Station to build and maintain reference collections of the various groups of plants and animals in the State. Much of the material in these reference collections was acquired while conducting the field studies as outlined in the introductory chapter of this bulletin. A small part has been acquired through purchase and a considerable portion represents salvage material—animals that have come to the laboratories from various sources and which have met death from various causes, mostly accidental or from sickness. This same policy is in force at the Huntington Forest and it is hoped that eventually the Museum will have representatives of every organism on the property from the smallest to the largest, both plant and animal.

Many of the species have been acquired already and these are being properly catalogued and will be stored in the newly completed fire-proof museum building for future use. Certain groups, now poorly represented, are destined to become more prominent in the collections in the near future because the physical developments of the Forest have now definitely reached the stage where they will demand less attention of the staff which in turn will be devoting a correspondingly greater amount of time to biological studies.

The reference collection of the Huntington Forest includes more than the plants and animals. It includes collections of fruits, seeds and other wildlife foods, and in addition various kinds of animal sign. These latter are not commonly found in reference collections and yet they are equally as important, if not more important than the other collected materials.

The terminology as applied to the various species in the reference collection will conform to that used on the "Faunal and Floral register". This register consists of large wooden panels placed against the interior walls of the museum and equipped with grooved strips of wood designed to accommodate numerous card labels. The common and technical names of each species are printed on a card label which is placed in the register in its proper taxonomic position. As fast as additional species are discovered they are entered in the register.

**Phenological Data.** It is known that certain wildlife phenomena are seasonal in occurrence. These include such activities as mating, nesting, egg laying, hatching, birth of young, emergence of hibernating species, moulting, departure of migrants, and numerous others. If, in recording these phenomena, calendar dates are used and comparisons between any two years are attempted it invariably results in errors because certain years are either late or early in their weather, and also in all the phenomena in any way dependent upon or determined by weather. If these data, recorded in reference to calendar dates, are compiled for a period of years this also results in the introduction of errors for the same reasons.

Knowing that many wildlife phenomena are determined by local weather (the extent to which this is true is not yet definitely known), it is possible to adjust the calendar dates for all seasons and all years to something near normal if there is available a cumulative record of the dates of typical seasonal phenomena during these years. Such a cumulative record is called a phenological table, and the dates may be referred to as phenological dates. These dates vary as much as two or three weeks in the same locality for the same species in different years, but they are of much greater value in wildlife work than are calendar dates alone. By recording the changes in plants it is possible to predict with greater accuracy the beginning and ending of some of these wildlife activities.

In order to determine the seasonal development of plants on the Forest four phenological plots have been established in various forest types, on several exposures, and at varying elevations. The forest

types included are spruce swamp, upper spruce slope at the top of Clearing Mountain, and a north and a south exposure in the northern hardwood type.

These plots are examined weekly during the growing season to record the changes which are occurring. Each plot is one chain (66 feet) square, and is so laid out that it includes a number of species of trees and underbrush. Herbaceous species are observed where they occur on the plot, and they are observed in minute detail on square-yard samples located at the corners of the plot. This method makes it possible to observe the same area and in many cases the same plants year after year to determine the seasonal correlations.

**Exclosures.** Two exclosures, each 250 feet long and 50 feet wide, were constructed with CCC labor within the check-area during late autumn, 1939. The posts and heavy fence wire were salvaged from the 10-acre deer enclosure at the Arbutus Camp headquarters, otherwise the cost would have been prohibitive at this particular time. The exclosure fences are about ten feet high—sufficient to prevent deer from jumping over, even in times of deep snow.

The sites for the exclosures were selected after the entire check-area had been visited with the view of locating extensive areas, uniform in forest cover and terrain, within which the necessary space could be obtained. Fortunately, the selected sites were not too inaccessible for transporting the workers and the fence material.

One of the exclosures has been placed near the truck trail between lines I and H in a typical northern hardwood type of forest at the base of the north slope of Catlin Mountain. It is not bordered by check-area lines, trails or truck trails. The other lies in the "bowl" east of Panther Mountain and is more or less hemmed in by Observation Mountain and Catlin Mountain to the south and east respectively. This is also in northern hardwood forest type.

Each of the exclosures will be divided into five equal parts or quadrats (50 feet square) one of which will serve as a control, the others to be further enclosed with various sizes of wire mesh to exclude animals of corresponding sizes. One of the quadrats will exclude even small song birds and consequently will need to be covered with suitable wire. Others will permit free access of such small animals, but exclude those of about the size of rabbits and larger.

The quadrats are expected to reveal much data on the ecological relations of some of the vertebrate animals on the Forest, particularly as regards their feeding activities. These data may well serve as a

basis for many research projects on wildlife that will be undertaken within the next few years.

**Natural Area.** On January 18, 1941, the Executive Committee of the Board of Trustees of the New York State College of Forestry, upon recommendation of the Dean, passed the following motion establishing a natural area on the Huntington Wildlife Forest Station:

"That in order to provide an area on the Huntington Wildlife Forest for long-time studies of natural conditions untouched by forest operations, the area bounded by Long Pond and Catlin Lake on the easterly side and by the boundary of the Huntington Forest on the westerly side and northerly sides be hereby set aside as a 'natural area', its boundaries be clearly marked on the Huntington Wildlife Forest map and on the ground and that definite, pertinent rules be drawn up by the Dean safeguarding the perpetuation of this area in a natural condition".

Provision has been made to maintain this natural area of approximately 1000 acres in such a manner as to eliminate as much human disturbance as possible. Practically the only individuals permitted to enter the area are those actually engaged on research projects. Any department of the College may initiate projects appropriate to the purpose of the natural area provided that the necessary arrangements have been made with the Dean and the Director of the Roosevelt Wildlife Forest Experiment Station. "It is to serve as an outdoor laboratory for studies of wildlife, flora, forests, soil and influences, and is admirably suited for long-time studies of conditions uninfluenced by anthropic factors. It is designed for investigations of the changes concomitant with the attainment of a dynamic equilibrium of flora, soils and weather, as well as fluctuations and variations in response to biologic and climatic cycles and to natural regeneration. Its position in the Huntington Wildlife Forest will permit it to benefit by the proximity of the technical headquarters of a field experiment station and to serve as an integral check area for purposes of comparison both with other and parallel experiments being run under disturbed conditions and with cultural operations throughout this part of the Adirondack Mountains." (Egler, '41.)

The natural area is quite isolated from the rest of the Forest and from the public. (See Map 3). The only individuals, other than research workers, that might enter the area would be hunters and these seldom, if ever, cross the boundary line. Various types of forest cover are represented and there are a few clearings that are

rapidly reverting to forest growth. Practically every type of habitat to be found on the Huntington Forest is represented in this area, although some are on a small scale.

## RESEARCH AND INVESTIGATIONS

**Limnology.** Limnological studies on the lakes and ponds occurring within the boundaries of the tract were begun in 1938 and continued each succeeding summer to date. Catlin Lake and Rich Lake have received the greatest amount of attention, but the other lakes are to be included so that ultimately a complete account of the waters will be available.

The lake survey program, as outlined on page 420, paved the way for the limnological work by making *accurate* contour maps of the lakes available from the very outset. The maps also provide detailed information on the location and extent of the various types of bottom. Information of this nature ordinarily is not commonly available to the limnologist unless special provision has been made.

The maps were used to good advantage in determining not only the number of field stations but their location as well. As a matter of fact plans of this sort might well be formulated in the office without devoting any time to preliminary scouting.

A total of thirteen stations was established on Catlin Lake, twenty on Rich Lake, nine on Wolf Lake, six on Deer Lake and six on Arbutus Lake. These were marked by wooden buoys to which were nailed numbered aluminum discs for identification. No two stations on any lake represented exactly the same set of conditions although in certain instances there were some similarities.

An attempt is being made to evaluate the amount of invertebrate food available to fish. Two bottom samples, making a total area of 72 square inches, were taken with an Ekman dredge from each station wherever possible. A Peterson dredge was used for samples from the sandy or gravelly areas. The samples were characteristically lacking in animal organisms. In fact some of the samples contained scarcely any macroscopic living material that could be utilized by fish. The commonest forms in the samples were chironomous and corethra larvae. Caddis larvae and mayfly nymphs also were represented, but largely in the sandy or gravelly areas. The shallow area with sandy bottom in the Rich Lake bay opposite the CCC Camp contained an enormous number of very small chironomous larvae. Several hundred were sorted from each square foot of bottom sample. Raw sewage from the camp is not emptied into the lake but the outlet from



Fig. 88. Loading the boat with limnological equipment. Ekman dredge, water sampler, plankton trap, plankton net and supplies.



Fig. 89. Taking water samples from various depths for chemical analysis. Field station marked with buoy at side of boat.

the septic tank extends about one hundred feet into the bay ending where the depth is about ten feet. Since the prevailing winds are from the northwest the waves naturally have a tendency to carry the water affected by the camp waste shoreward. This, undoubtedly, accounts for the unusual abundance of chironomids in that particular part of Rich Lake.

Samples of bottom invertebrates were also taken at various special stations not included in the regular stations. Several samples of invertebrates were taken from beneath rocks in Graveyard Bay of Rich Lake. These contained a good many mayfly nymphs, a few hellgramites and caddis larvae. Fresh water sponges, which abound in shallow water in most of the lakes, harbor many larvae as do the numerous colonies of bryozoans (*Pectinatella magnifica* and *Cristatella mucedo*). The gross vegetation frequently supported numerous leaf-beetles such as larvae and adults of *Donacia pulmata*, masses of mayfly eggs and caddisfly eggs (*Phryganea*).

*Vegetation.* Considerable attention has been given to the gross vegetation of the lakes because it is recognized that fish are dependent to a large degree on the kinds and abundance of the plants present. It is recognized also that aquatic plants not only provide cover for certain species of fish, but they harbor food organisms and provide spawning sites for some fishes as well.

The ratio of plant areas to barren areas is very great in the larger lakes. In fact, the gross vegetation practically disappears beyond the ten-foot contour. The zone of greatest abundance is in the region of the five-foot contour.

Great numbers of small golden shiners (*Notemigonus crysoleucas*) were found amidst the vegetation and in the adjacent shoreward areas. This species appears to be the most numerous and thus the most important forage fish in the lakes. The vegetation also harbors other fishes such as common sunfish, red-bellied sunfish, red-bellied dace, horned dace, yellow perch, and young common suckers. Then, too, certain food and game fishes occasionally enter the weed beds, particularly at night, apparently to feed on forage fishes. Large brook trout have been found throughout the summer amidst such vegetation where the water temperature was warmer than that normally chosen by this species.

The lakes support about three dozen species of plants, more than one-half of which are of the emergent type. The habitats of the various species of plants are being plotted on the lake survey maps. These data have already been acquired for most of the lakes.

*Temperatures.* A series of temperature readings was taken at regular intervals throughout the summer months at the various field stations in order to obtain data on thermal stratification. The temperatures were taken by means of a deep-sea reversing thermometer as well as by a regular thermometer. The readings with the regular thermometer were taken directly from the water samples, largely as a means of checking the accuracy of the reversing thermometer, but also for comparison of the efficiency of both instruments.

The largest lakes (Rich and Catlin) have a maximum depth of around 55 feet each. After the spring turn-over is complete the difference in temperature between the surface and the bottom water gradually increases until the maximum is reached in July. From then on until autumn there are approximately 16 degrees difference in temperature with the greatest change taking place at about 25 feet. In the deepest portions of these two lakes the minimum summer temperature is between 7 and 8 degrees Centigrade.

It is definitely known that during the summer the lake trout population of these waters is concentrated within the confines of the areas having sufficient depth to maintain these minimum temperatures. It is definitely known, too, that the lake trout leave the deeper waters particularly in the spring and in the fall. They have been observed spawning on rocky shoals in October in water as shallow as three or four feet.

*Turbidity.* Turbidity tests made with a Secchi disc showed that Catlin Lake was considerably clearer than Rich Lake. The disc disappeared at approximately twelve feet in Catlin Lake and at seven feet in Rich Lake. The greater density of Rich Lake may be partly attributed to the brownish color known as "bog stain" which is more pronounced in this lake than it is in Catlin. This greater density should make a corresponding difference in the depth at which photosynthesis is effective.

*Hydrogen-ion Concentration.* The degree of acidity of the water at various depths in the lakes is being determined by means of a Hellige pH comparator, using a solution of chlorophenol red as an indicator. Catlin Lake and Rich Lake have been completed and the tests show that both of them are slightly acid and that the degree of their acidity is about the same.

The surface waters in each lake gave a pH rating of 6.4-6.6. Vertical readings at 5-foot intervals from the surface to the bottom indicated a gradual increase in acidity with 5.5 as the rating for the deepest portions. The acidity at the bottom is thus sufficiently low

to be unsatisfactory for trout or other fish. Chemical analyses of the water in the two lakes revealed that there was a corresponding increase in the amount of free carbon dioxide with the increase in acidity.

*Plankton.* Plankton samples have been taken from all of the lakes although particular attention thus far has been given to Catlin and Rich Lakes.

The surface plankton were obtained with a closely woven plankton net while the plankton at sub-surface 5-foot intervals were obtained with the plankton trap. The samples were taken at various times throughout the summer in order to determine the population peaks of the various species particularly the plant plankton that habitually "bloom".

The crustacea were represented in Catlin Lake by such genera as *Cyclops*, *Daphnia*, *Diaptomus*, *Bosmina*, *Sida*, *Holopedium* and *Lepidodora*, listed in their order of abundance. Rotifers were found in nearly every sample taken from Catlin Lake, but the genera *Anuraca* was more generally represented than was the case with the following: *Notholca*, *Polyarthra*, *Conochilus*, *Rattulus* and *Rotifer*.

The flagellate protozoa were conspicuously represented in Catlin Lake by two species of *Dinobryon* (*D. bazaricum* and *D. setularia*) and to a lesser extent by other genera. *Dinobryon* were found in practically every sample.

The phytoplankton have not been fully determined for any of the lakes. It is evident, however, that a good many genera are represented among the Cyanophyceae, Chlorophyceae, Desmidiaceae and Bacillariaceae. Some of the common genera are *Coclosphaerium*, *Microcystis*, *Anabaena*, *Ankistrodesmus*, *Kirchneriella*, *Pediastrum*, *Micrasterias*, *Staurostrum*, *Tabellaria* and *Asterionella*. These are sufficiently common to materially affect the fish population in the lakes, either directly by providing food for the fry, or indirectly by providing food to certain invertebrates that are potential food for fish.

*Chemical Analyses.* Samples of water from the surface and at 5-foot intervals to the bottom were taken with a Foerst improved water sampler, for analyses to determine the amount of oxygen and the amount of free and fixed carbon dioxide. Both Catlin Lake and Rich Lake have been completed and work on the other lakes is in progress. Free carbon dioxide was found in every sample and usually there was a gradual increase in volume from surface to bottom. The samples of surface water showed less than 1 cc of carbon dioxide per

liter of water for each station of the two lakes. The Catlin Lake stations consistently showed a slightly higher volume of carbon dioxide for the various sub-surface levels than did Rich Lake. For instance the forty-foot depths of Catlin Lake showed 7.331 cc of carbon dioxide per liter of water while similar depths in Rich Lake had approximately only 5 cc. There was one notable exception in the case of Station 19 and to a lesser extent Station 20 of Rich Lake which were located near the outlet. Station 19 which had a maximum depth of only 35 feet contained 10.666 cc of free carbon dioxide per liter of water and, as will be noted below, contained scarcely any free oxygen.

Free oxygen naturally became scarcer with increased depth and the corresponding increase in amounts of free carbon dioxide. The surface waters contained slightly more than 5 cc of oxygen per liter of water while the samples at 40 to 50 feet contained about 2.5 cc per liter. The high carbon dioxide content of the water at Station 19 in Rich Lake was accompanied with a correspondingly low volume of oxygen. The samples taken at 35 feet had only .254 cc of oxygen in each liter of water and this is quite insufficient for the welfare of fish. Fortunately only a relatively small area is involved in this low oxygen content portion of the lake.

**Dwarf Sucker Study.** Another season (1940) of field work has been accomplished on the dwarf sucker since the publication of the "Progress Report on a Study of the Dwarf Sucker (*Catostomus commersonnii utawana*)" (Dence, '40). The same area (Wolf Lake) was used as in previous seasons and, in general, the study itself was conducted in the manner previously employed. The breeding suckers appeared on schedule, as usual (May 25, 1940) and practically every fish had vacated the spawning streams by June 6.

Most of the fish arrived on the spawning beds during the first four days of the season, and these had a sex ratio of about two males to one female. New arrivals after that date were represented by about as many females as males. In fact the females actually exceeded the males in numbers with respect to new arrivals on five days. Most of the males, and to a considerable degree the females as well, that appeared towards the end of the season were smaller than the average run. Many of these were considered to be individuals experiencing their first breeding period migration.

A total of 3201 dwarf suckers, representing 2074 males and 1127 females were caught and marked, by removing certain of the lower fins, during the 1940 season. About 40 percent, or 1295, of these

suckers had been marked during one or both of the previous seasons. It is interesting to note that 9.3 percent of the catch, or 298 individuals, now have as many as three missing fins. Since the study will continue for at least two additional years certain individuals may eventually lose as many as five fins. The loss of fins appears to produce no noticeable handicap to the fish concerned. In fact if the amputations are not properly made the fins will regenerate, although the regenerated fins are generally malformed.

While most of the marked suckers returned to the same inlet which they had previously used for spawning purposes a number, as mentioned in the earlier progress report (Dence '40), had migrated from one end of the lake to the opposite end. The greatest shift was from the South Inlet to the North Inlet—from the smaller to the larger stream. Thus twenty-seven fish that had been marked in the South Inlet in 1939 were taken in the North Inlet in 1940. Three others had spawned on two successive years in the South Inlet before changing to the North Inlet. There were various other less extensive combinations of changes in spawning habitats. These will be described in the final report.

The summary of the data for the three seasons shows that a total of 5896 individual dwarf suckers (recoveries excluded) have been marked. Two hundred and ninety-eight of these have been recovered and remarked on two successive years. An additional group of 115 suckers marked during the first season were recovered for the first time during the third season (1940). In other words 413 or about twenty percent of the 1996 suckers marked in 1938 were recovered in 1940.

About 70 percent of the total number of suckers, exclusive of recoveries, captured during the three years were males. This makes an average of slightly more than two males for each female. This sex ratio corresponds very well with that of a single spawning group which normally consists of one female and two males.

A few typical normal-size female common suckers (*Catostomus commersonnii commersonnii*) appeared in the North Inlet along with the dwarf suckers. The three that were captured measured about twenty inches in standard length and weighed between six and seven pounds. They appeared to be "giants" in comparison to the dwarf suckers.

**Ruffed Grouse.** After two seasons' work on the Forest Johnson (1937) says: "From the observations of these two seasons it cannot be said that the ruffed grouse is a common bird on much of the tract."



Fig. 90. One of the grouse traps and its accompanying shelter.



Fig. 91. Some of the equipment used in marking grouse. Banding cone, leg bands, pliers, colored feathers and note book shown in photograph.

There is no evidence that its status has improved since that time. Although it is present throughout the area its occurrence in specific habitats is to a considerable extent seasonal. There is also some evidence of altitudinal migrations related to seasonal progression.

Since October, 1938, monthly censuses of the species have been attempted through use of the strip-census method. As this method is based on average flushing distances, no census calculation is possible unless a representative number of flushing distances is obtained. Due to the scarcity of birds few censuses have provided sufficient data on which to base a calculation. Walking out the 55 miles of line on the check-area rarely results in putting up more than 15 birds. On the basis of such data as we have it is reasonable to assume that the fall populations for the past four years have not exceeded one bird per 35 acres, and spring populations for the same period have been less than half that number, that is one bird per 75 to 100 acres.

No definite conclusions as to the cause of this condition are possible at this time. It is, however, quite apparent that winter foods for this species are so scarce as to be almost nonexistent on the Forest area.

**Distributional Study of Small Mammals.** This is really a continuation of studies begun by the Roosevelt Wildlife Forest Experiment Station in 1930 near Syracuse and continued during the succeeding six years in various localities about central New York and in the Adirondacks. A portion of the data from these studies has been published in the *Roosevelt Wildlife Annals* (Townsend, '35). The studies during the last year (1937) were conducted on the Huntington Forest, although very little progress was made due to unfavorable climatic conditions and illness in the personnel.

The check-area was established at the Huntington Forest in 1938 as a place for conducting intensive studies on wildlife with the view to obtaining data that might be used in formulating wildlife management policies. The term "wildlife" was to be considered in its broadest sense and as such was to include all the animal species, both game and non-game.

The small mammals have a very important bearing on the game species because they serve as buffers. When predatory animals are feeding on small mammals the game species are being spared. Theoretically then, there should be a direct relation between the relative abundance and distribution of the small mammals and the abundance of game species. The regular monthly censuses provide

data on distribution and abundance of grouse and the larger mammals, but, excepting squirrels and chipmunks, practically nothing on the small mammals.

The new distribution study on small mammals was begun during the summer of 1940 and will be concluded in 1941. The work has been greatly facilitated by virtue of the check-area with its numerous accurately marked stations. As a matter of fact approximately 400 trapping stations have been established on the Forest, the majority of which are on the check-area. Since the trapping stations are located at one-fourth mile intervals along the check-area lines as well as at other places the resulting random samples should give a true cross section of the population for the entire area.

Ten live traps of the Townsend type were set for a period of five days at each trapping station within the check-area and the captured animals were marked with numbered ear tags and released at the place of capture. Ordinary wooden-base mouse traps were used elsewhere. The bait in either case was a standard mixture of peanut butter, chopped raisins and shredded cocoanut. The traps were visited each day.

A description of the forest type and its subordinate vegetation has been recorded for each of the trapping stations. The sex and, when possible, the age of each captured animal has been recorded. The dead animals were taken to the laboratory, carefully measured, weighed and sometimes salvaged for museum skin specimens or for the skeletal reference collection.

Both the floristic map and the new topographic map of the check-area will greatly assist in interpreting these data on the distribution and relative abundance of the small mammals.

White-footed mice (*Peromyscus maniculatus gracilis* and *Peromyscus leucopus noveboracensis*) were the most abundant species taken in the traps. Meadow mice (*Microtus pennsylvanicus pennsylvanicus*), red-backed mouse (*Eutamias gapperi gapperi*), woodland jumping mouse (*Napaeozapus insignis insignis*), chipmunk (*Tamias striatus lysteri*), short-tailed shrew (*Blarina brevicauda*) and masked shrew (*Sorex cinereus*) were well represented but not so generally distributed as were the deer mice.

**Clearings and Plantings.** Johnson ('37, p. 560) describes the Huntington Forest as follows: "Excepting the former farm land adjoining the Long Lake-Newcomb highway that traverses the southernmost corner of the tract the land surface is covered principally with a typical hardwood forest including an admixture of varying

amounts of hardwoods." This "typical hardwood forest" is far from being an ideal habitat for certain species of wildlife because of its failure to produce the proper kinds and amounts of food throughout the critical winter months. Ruffed grouse appear to be suffering more in this respect than other game animals.

While there were a few small clearings on the tract when the College acquired the property these had been allowed to reforest naturally or had been planted to conifers. None of these clearings are especially productive of winter foods although some of them do produce an abundance of late summer and autumn fruits such as raspberries and blueberries. Three additional clearings of approximately one-half acre each were made along the truck trail during the time when this trail was under construction (Fig. 94). These were intended to be test clearings and as such were not replanted but allowed to reforest naturally. The results exceeded expectations not only in the production of wildlife foods but also in the amount of wildlife frequenting the areas. Deer, especially, were quick to take advantage of the opportunities afforded by these new environments and both adults and young frequented the areas throughout the summer.

These test clearings gave such promising results that it was decided to experiment further by establishing a total of twenty-one clearings, one-half-acre to three-fourths-acre in size, at various points throughout the 800-acre aspen, yellow birch and black cherry stand north of Rich Lake (Figs. 92 and 93). This particular site was chosen for two reasons. It has very little commercially valuable tree growth and is practically useless for wildlife due to the absence of winter foods and cover.

Twelve of the proposed plots were cleared as a CCC project during the winter of 1939-1940 and these were planted with mountain ash, red-osier dogwood, arbor vitae, red oak and wild grape the following spring. Ten additional plots were cleared during the winter of 1940-1941 and two were planted the following spring with mountain ash and flowering crabapple. The others will be planted as soon as planting stock is available.

The choice of species used in planting the plots was made largely on the basis of availability of planting stock, but with the thought of establishing plants that would provide more wildlife food, particularly fruits.

Deer began browsing in the plots almost immediately after the plantings were made and some of the planted stock suffered the same fate as the new coppice growth. Two large bucks were observed re-



Fig. 92. One of the clearings made in the aspen, yellow birch and cherry stand north of Rich Lake during the winter of 1939-1940.



Fig. 93. Close-up of stand in which clearings were made.



Fig. 94. One of the test clearings along the truck trail in winter garb. Clearing made in 1937, photograph January, 1939.



Fig. 95. Edge of Arbutus Lake in February, 1941.

peatedly throughout the summer in a plot near the truck trail and most of the mountain ash in that plot showed signs of browsing by late autumn.

An attempt is being made to protect the plots from deer browsing through the use of fences made from the trees cut on the plots. Likewise some consideration is being given to the use of electric fences.

The discouraging of reproduction of the undesirable species, particularly coppice growth, is another problem. There appears to be no alternative but to cut the undesirable growth. This may prove to be a necessary procedure until the planted stock becomes established.

**White-tailed Deer Study.** More interest has centered around the white-tailed deer than any other game animal on the Forest. The average layman is interested in the animal for aesthetic reasons; the hunter from the standpoint of sport; the forester from the silvicultural standpoint; and the wildlife student from the point of view of the field biologist. All of these interests, except that of the sportsman, can be satisfied on the Huntington Forest.

Deer have been quick to respond to the protection afforded by the Forest. It is not unusual to observe from six to a dozen or more animals on a trip over the truck trail in late afternoon or at night. The average person enjoys this privilege regardless of his interests or the number of times he has seen deer. The visitor who has never before seen deer in the wild carries away a lasting memory.

Although it has always been known that deer are browsing animals, it has been recognized only recently that certain tree species are browsed to the extent that they are held in check while other species continue unmolested and eventually become dominant.

Pearce ('37) concludes that "deer feed on practically every woody plant except spruce, when in yards of the western Adirondacks"; that "deer may enable red spruce to assume dominance by selective browsing on its competitors"; and finally that "when red spruce is not dominant, as in most spruce flat regeneration, stand composition is nevertheless influenced because of damage to competitors".

Casanova (unpublished thesis written in 1940) studied the influence of deer on balsam fir in determining the composition of the forest. He concluded that while deer browse extensively on balsam fir a few trees seemingly escape by virtue of their tolerance to shade and the great number of seedlings produced.

The failure of aspen to reestablish itself in the old burns following a heavy cut by beaver has been partially blamed on deer and there appears to be some merit in the accusation. Likewise deer are said

to be responsible for the so-called "deer-line" on cedars bordering certain Adirondack lakes. This theory, however, is open to question. These and similar problems relating to this species are being investigated on the Forest for it is clear that much remains to be learned about white-tailed deer despite the fact that many investigators have studied certain phases of its life-history and habits. In fact so little is known about the species in this region that management plans are still based largely on theory.

The deer herd on the Huntington Forest is definitely on the increase and is rapidly approaching, if it hasn't already reached, the carrying capacity of the area. A deer drive made in December, 1939, with the help of more than one hundred men covered a six hundred-acre section of the check-area. A total of thirty-nine animals was driven from the area—one animal to each 15.4 acres. It is believed that this is fairly representative of the deer population for the entire Forest area.

The regular monthly distribution studies taken during the past thirty-five months have furnished much valuable information, particularly for the winter months. These data have special significance inasmuch as few investigators have had an opportunity to study the Adirondack deer in their winter environment and therefore have published very little on the habits of the species for that season.

One of the most interesting observations to date has to do with feeding habits. Immediately after a few inches of snow covers the ground, the animals feed to a considerable extent on rhizomes of the common wood fern. They are capable of finding these even when the snow is over a foot deep and the fronds are matted level with the ground. The fronds apparently are not eaten because they are frequently left on top of the snow or are severed from the plant. Usually only a small portion of the rhizome is consumed—that part immediately adjacent to the point where the fronds are attached.

The problem of getting food becomes really acute when the snow is a foot to four feet deep. It is then no longer possible to dig for fern rhizomes and much of the witch hobble is covered. Some animals are fortunate enough to find a few hemlock boughs that have been dropped by porcupines, others may find a balsam that has been blown down during a storm. These are utilized to the fullest extent. A fall of soft soggy snow occasionally brings the lower branches of trees within reach of the animals and provides an abundance of food for a time. Mosses and lichens from trees are taken on occasion, perhaps to a greater extent than we realize, because deer leave no sign except tracks in the snow when feeding on these materials.

A considerable number of deer that has failed to survive the rigors of winter are found each winter, especially during late winter. Most of these have been partially eaten by foxes, but the skulls are frequently available so that the approximate age of each may be determined. Fawns are more commonly represented than adults although during the winter of 1938-1939 old deer were more common than fawns.

The tagging experiments have revealed interesting data particularly as regards the cruising radius. A spotted fawn tagged early in July, 1938, was found dead the following February, less than a quarter-mile from the place where it was tagged. An old doe tagged during the winter of 1939-1940 was seen repeatedly throughout late July and early August, 1940, at about the same place along the truck trail. She gave birth to a fawn and it was tagged early in the summer. The cruising radius of these animals was approximately one-fourth mile during the period while under observation. On the other hand a deer that had been tagged on the check-area now loiters about Arbutus Lake headquarters, which is at least two miles from the place where it was tagged. Its cruising radius appears to be not over one-fourth mile at the present time.

Liver flukes are rather common in adult deer but they appear to have little effect on the physical condition of the hosts. Some of the deer examined during the winter were found to be heavily infested with lice and in addition harbored a few hippoboscids.

**Live Trapping and Marking.** Up to June 1, 1941, the following vertebrates, exclusive of fish, have been caught, permanently marked, and released on the Huntington Forest.

White-footed mice ( <i>Peromyscus</i> spp.)	139
Woodland jumping mouse ( <i>Napaeozapus insignis</i> )	3
Red-backed mouse ( <i>Evotomys gapperi</i> )	19
Chipmunk ( <i>Tamias striatus lysteri</i> )	27
Flying squirrel ( <i>Glaucomys volans</i> )	1
Raccoon ( <i>Procyon lotor</i> )	4
Red fox ( <i>Vulpes fulva</i> )	3
Varying hare ( <i>Lepus americana</i> )	12
Red squirrel ( <i>Tamiasciurus hudsonicus</i> )	15
White-tailed deer ( <i>Odocoileus virginianus</i> )	29
Chimney swift ( <i>Chaetura pelagica</i> )	1
Barn swallow ( <i>Hirundo erythrogaster</i> )	1

This comparatively small number of marked animals, except in the case of the varying hare and the white-tailed deer, represents only those that have been caught in connection with other special projects. A concerted effort, however, was made to trap the varying hares and the deer for the express purpose of marking them, determining sex

ratios, and in the case of deer, obtaining data on weight. The data already obtained from marked animals more than compensate for the time and expense involved and provides ample justification for the continuation and expansion of the project on a greater scale. The necessary equipment such as traps, tags and bands is in readiness at all times so that there need be no delay in resuming the work whenever conditions are right, or whenever, through any circumstances, live specimens come to hand.

A varied assortment of live traps, designed to trap various species of animals, has been provided with the aid of CCC labor from specifications and plans prepared by the Roosevelt Station staff. The deer traps are the only ones that have been used extensively to date. They have been in operation for a short period during each of the past two winters. The grouse traps (Fig. 90) have been used only a short time.

The deer traps have attracted considerable interest because they have not been used commonly in this State. The trap is known as the "Stephenson deer trap and banding cage", originally designed by the Game Division of the Michigan Department of Conservation. It is a box trap, approximately twelve feet long, three feet high and three and one-half feet wide, with a door at each end. The end doors drop simultaneously when a deer releases the trigger which is fastened to a wire covered with bait and stretched across the bottom of the trap. A small slide door near one end of the trap leads to the banding cage, which is small enough to keep the captive animal in close quarters while being weighed, sexed, tagged and, if desired, transported to another locality.

This type of trap works successfully during fair weather. Rain or sleet storms and, to a certain extent snowstorms, usually render the traps useless until the ice is removed from the door channels. The best results are obtained in late winter after the snow becomes so deep that deer find it more convenient to use paths made by the attendant rather than to make their own. Browse scattered along the paths leading to the traps is taken freely and consistently under such conditions. Incidentally two deer have been found in the same trap on several occasions.

The eight traps used thus far have been permanently placed in habitats commonly used by deer in winter. One small buck was caught eleven times during February and March, 1940, in trap number 6. Another deer was caught eight times during the same period but in four different traps—all within a radius of three-fourths of a mile. Its last appearance was in the trap where it was marked. Still

another deer caught twice in trap number 5 during February and March, 1940, was caught in the same trap a year later. There are several instances of animals retrapped four and five times during the same winter.

Data of this kind have been obtained from other species of marked animals. Several of the 139 white-footed mice, for example, that were marked during the summer of 1940 remained in the same locality where originally taken and entered traps on three or four successive days. One animal even re-entered the trap within five minutes after it was tagged and released. In one instance a mouse marked on June 8 was recaptured on June 10 at a point 11.2 chains distant from the original place of capture.

Information of this kind adds to the cumulative knowledge relative to the life-histories and habits of the wildlife on the Forest and is being acquired for future use in formulating management plans. It is recognized that the results from such a small number of marked animals cannot do more than suggest trends or theories, and as such cannot be accepted without reservation. Since this project is destined to continue for an unlimited time eventually there will be sufficient data to serve as a basis for definite conclusions.

The Forest offers unusual opportunities for work of this sort by virtue of the fact that it is under the direct control of only one agency, free from trespass and, most important of all, dedicated to one purpose.

*Fish tagging.* As stated in the section on "Research and Investigations", several thousand dwarf suckers have been marked by clipping certain lower fins. This is a very rapid and economical method of marking quantities of fish, but has the great disadvantage in that it is impossible to acquire data on individuals. On the other hand it is the only known practical method that can be used in marking certain species of fish such as the dwarf sucker.

There are, however, a number of fish species that can be successfully marked with jaw tags and a considerable number including brook trout, common sunfish, red-bellied sunfish, yellow perch, rock bass, large-mouth black bass and small-mouth black bass have already been marked in that manner. Furthermore present plans call for the marking of many more as the work progresses.

The ultimate goal is to accumulate sufficient basic knowledge on ages, growth, migration, longevity, etc., to provide a basis for fish cultural practices on the Forest. This type of work is being done elsewhere, but not under the same circumstances and usually not in territory unmolested by the public.

**Status of Various Vertebrate Species.** *Snowshoe rabbits.* When the College first acquired the Huntington Forest snowshoe rabbits were so scarce that only an occasional individual was observed and the population appeared to be restricted to that part of the Forest adjacent to the highway characterized by open fields and coniferous plantations.

There was no noticeable increase in the rabbit population until the winter of 1938-1939. Tracks were reported that winter from various parts of the Forest by the men engaged in making the regular monthly grouse census and animal population studies. This, evidently, formed the nucleus for a greater population because there was a decided increase the following year, possibly as much as 200 per cent. A few of these were caught in live traps and marked with ear tags before releasing. There appeared to be no increase this past winter (1940-1941).

The places of greatest concentration are the bracken areas where aspen and several species of undergrowth such as witch hobble (*Viburnum alnifolium*), fly honeysuckle (*Lonicera canadensis*) and various hardwood species reproduction provide ample food. The peaks of some of the mountains such as Catlin, Observation, Panther and Moose are also well populated, particularly the first-mentioned. Red raspberry patches and their associated plants usually occur in the more open areas on the mountain peaks and these appear to meet the necessary requirements.

The accumulated data on the snowshoe rabbits suggest that the population was at the low of a cycle when the Forest was first acquired and that the peak has been or soon will be reached. The monthly distribution studies during the next few years will undoubtedly produce valuable data on this species with respect to its cyclic tendencies.

There have been no introductions of snowshoe rabbits on the Forest or, so far as we are aware, in the general locality so that the increase has been strictly natural.

*Mink.* It appears that mink are more abundant on the Forest than was suggested by Johnson ('37). The animals characteristically inhabit the regions adjacent to the lakes and water courses, particularly the former. The majority of the sight records are for mink that were observed traveling along the lake-shores, at the water's edge, during July and August. They were seen frequently from a boat at Catlin Lake while the limnological studies were in progress throughout July and August, 1939. The animals on these occasions were



Fig. 96. The large marsh meadow at the head of Rich Lake. Favorite habitat for deer, waterfowl and several species of fur-bearing animals.



Fig. 97. Dense patch of bracken fern in the old burn near Deer Lake. Beaver have removed the aspen and the deer are preventing the balsam fir from getting a start.



Fig. 98. Heavy deer browsing on balsam fir. Clearing adjacent to Catlin Lake.



Fig. 99. Old log torn to pieces by black bear. This is a common sight in August and September.

always solitary and always appeared to be in a hurry. Certain individuals were closely watched through field glasses, while they hurried along a half-mile or so of shore line. They seldom hesitated even when their pathway was blocked by large boulders, steep cliffs or other obstructions. If there was no convenient means of making a detour over land they did not hesitate to detour by way of the water.

A family group was encountered on July 11, 1938, in a small beaver pond near the headwaters of Deer Creek. Three young and a large black adult were in sight at one time. There may have been others in the group as it was difficult to make certain of the number due to the rank vegetation coupled with the great activity of the various members. The young were fairly tame and showed no particular concern over the observer's presence. The habitat pond supported a large population of red-bellied dace (*Chrosomus cos*), black-nosed dace (*Rhinichthys atratulus*), horned dace (*Semotilus atromaculatus*) and red-bellied sunfish (*Lepomis auritus*).

Tracks are occasionally observed in the snow during the regular monthly censuses, particularly in the early part of the winter in areas adjacent to water.

*Black bear.* Bears are so shy and retiring that one is more likely to be made aware of their presence through finding sign rather than from actual observation. Bear droppings are frequently found along the trails and give a definite clue to the seasonal changes in the food habits of the animals. Succulent vegetation forms a considerable portion of their diet in the spring as do fruits and nuts of various sorts in the late summer and early autumn. Grubs, ants and other insects supplement the fruit diet in the autumn as indicated by the numerous dismantled rotten logs and stumps that are found at that time.

The staff members occasionally come across an individual bear, or a family group, usually the latter. More frequently, however, strong odors, sounds of running animals, or other sign indicate the proximity of bears that are not actually seen.

The Huntington Forest bears seem to have taken a great dislike to the numerous orange-colored white pine check-area signs and each year chew a number of them into bits. The cloth trespass signs suffer a similar fate, although the damage in this case is done with the claws. Sometimes it appears as if the bears follow a certain line when bent on destruction and take each sign in turn. Even the orange-colored rings that have been painted on trees are not immune to attack for some of them show deep claw gashes.

*Otter.* Johnson ('37, p. 600) describes the otter population on the Huntington Forest as follows: "Tracks were noted on the beach at the north shore of Wolf Pond in August, 1933, and in June, 1934. In August of the latter year I noted tracks also on the southeast shore of Deer Pond. Chief Ranger Oja reported seeing tracks and 'slides' along Deer Pond and Wolf Pond brooks, in February, 1933. Early in January, 1937, he saw three large individuals near the Rich Lake dam."

A family group of four individuals (one adult and three young) were observed for a considerable time on July 12, 1938, as they played and fed in a beaver pond near intersection K-9 of the check-area. Later in the summer this, or a similar, group was observed in Catlin Lake and one of the young was taken for the museum collection. Early in May, 1939, a large individual with one foot missing was encountered in a spring rivulet that flowed through the bracken fern area. Then, later in the same summer a group of three was observed in the Catlin Lake bay near the mouth of Deer Creek. The animals had small fish in their mouths on several occasions when they came to the surface. Another otter was observed on April 15, 1941, in the beaver pond at K-9. A family group was seen in Wolf Lake on several occasions during the past summer.

In addition to the animals actually seen, tracks are found frequently during the winters. While it is quite certain that the species reproduces on the Forest yet the population appears to remain about the same. Possibly some of the animals are trapped when their travels carry them beyond the Forest boundaries.

*Red Fox.* The red fox occurs quite generally over the entire Forest and appears to be increasing in numbers. During the spring, summer and autumn the animals are observed quite frequently, particularly along the truck trail at night. Perhaps the greatest number are observed during the latter part of May and the early part of June for at that time the pups emerge from the dens and since they are not as wary as the adults the chances of finding them are much greater. The animals are active throughout the winter although there is more activity during the early and late winter than at mid-winter. Tracks in the snow reveal the distribution of the animals and yield much data on their habits.

The bracken area in the Deer Lake region appears to be a favorite habitat for foraging as well as for breeding. A number of dens inhabited with fox pups are found there each spring. Last winter at the time of the regular February census (February 15) foxes were

barking throughout the bracken area and a number of them was seen. The tracks indicated that the animals may have been traveling in pairs or that the females were being followed by males. Usually there were two or more sets of tracks close together. The barking was heard on two successive days.

Foxes are frugivorous to a considerable degree during the summer and the numerous droppings found indicate that red raspberries, blueberries and other fruits are taken quite freely at that season. They are scavengers to a large degree during the winter, particularly on deer carcasses, and to a lesser extent on grouse and other animals.

Fox tracks are frequently observed in the sand at the edge of the water in the two inlets of Wolf Creek occupied by spawning dwarf suckers during the latter part of May. They have been suspected of killing some of the suckers that are found partly eaten each season. There is a possibility that the foxes may only help to devour what has been destroyed by other marauders.

*Canada porcupine.* This rodent occurs rather commonly throughout most of the Forest although there are a number of boulder ledges where considerable concentrations exist. Some of these ledges are well towards the summit of the higher mountains but others occur in more level territory.

The animals are active throughout the winter, but do not range very far from their dens at that season, especially if the snow is deep. Usually the trails extend from the den to the nearest food tree.

The feeding habits of the porcupine on the Forest change markedly about the first of October each year. At about that time they begin feeding on the bark near the butts, showing a marked preference for large sugar maple, beech and yellow birch. It has been observed in many instances that the adventitious growth surrounding previous injury is attacked first. This may have greater nutritive value than normal bark. Some hard maples show evidence of attack for three or more successive years with the result that girdling is practically complete. Later in the season the animals are more inclined to feed on the bark of saplings, or the twigs of hemlock cut well up in the crowns. The animals inadvertently drop a few of the hemlock twigs. This is advantageous to deer, especially at critical periods, when they appear to loiter about porcupine feeding trees for the express purpose of securing this material. The snow beneath these trees is always well trampled by deer and some of the animals even "bed" in such places.

Tree seedlings are frequently cut and devoured during the spring and summer months, therefore one finds less conspicuous signs of their presence at that time than in the fall and winter. The animals appear to require considerable mineral matter as they often feed on deer antlers and bones.

Porcupine occasionally become troublesome about the living quarters, but in general, they cause only slight damage. The policy has been to exercise control rather than attempt extermination on the Forest.

*Beaver.* Beaver exhibit a greater fluctuation in numbers than most of the animal species on the Forest. This fluctuation is due in part to trapping near the boundary during the periodic open seasons, but more largely to the amount of accessible aspen, their principal food species.

There were only a few beaver on the Forest at the time it was deeded to the College, but there was much evidence of former occupancy. It appears that most of the lakes and streams were inhabited with beaver during the peak of their population in the State prior to the first open season in 1924. A small colony existed in each of the following areas in 1933: Arbutus Lake, Belden Lake, Deer Lake and the outlet of Corner Pond. Most of the beaver now on the Forest are working in the Deer Lake region. Much of the forest adjacent to this lake was burned in 1908 and is now covered with the typical post-fire species of trees and plants such as aspen, fire cherry and bracken fern. The aspen attracts the beaver and they have been cutting it so thoroughly that the present available supply is about exhausted. It is very evident that the available aspen supply will be removed within the next few years.

Unfortunately for the beaver, aspen has not reproduced successfully on the areas denuded by the beaver in recent years so that it now appears the animals will of necessity soon seek other territory, outside the boundaries of the Forest. There is no apparent reason for the failure of the aspen to successfully reproduce. Deer are known to frequent the areas throughout the growing season, but it has not been definitely determined that they browse extensively on the aspen sprouts. They do, however, feed very extensively on balsam reproduction wherever it appears in the association. While the bracken fern grows quite luxuriantly throughout the area it seems improbable that the resulting shade would be sufficient to eliminate all chances of aspen reproduction.

Plans are already underway for a study of this beaver food prob-

lem. Markers were placed near several hundred aspen sprouts two years ago making it possible to acquire data on the history and development of individual stems.

*Red Squirrel.* This mammal is recorded more frequently during our regular monthly population studies than is any other; practically every coniferous thicket, large or small, harbors one or more of these animals. Figures thus far obtained indicate that they are increasing in numbers.

The greatest value of the red squirrel seems to be the rôle it plays as a buffer, relieving to some extent the pressure on species less able to withstand predation. When predatory animals are feeding on red squirrels other animals are being spared. The most destructive rapacious birds on the Forest—the great horned owl and the barred owl—feed rather extensively on the red squirrel, particularly during the winter when smaller rodents and songbirds are not so easily obtained as at other seasons.

Fitzwater ('41) studied the red squirrel as a problem in fulfilling the requirements for his Master's degree at the College. He gave particular attention to territorialism, activity, and census methods. Considerable time and effort were devoted to developing a satisfactory method of marking the animals so that they could be easily identified at sight in the field. Numerous dyes were used in the experiments, but most of them failed to meet the requirements. Nyanzol and sodium picric acid were especially good and some of the animals marked with these dyes in February still retained the color when last observed (May 28). Picric acid (crystals) appeared to have possibilities although it was not given sufficient tests to warrant definite conclusions.

*Chipmunk.* Chipmunks reached a very low point in population density immediately following the severe winter of 1933-1934, which was characterized by prolonged periods of extreme sub-zero temperatures. Only an occasional chipmunk was observed during the following summer, but these survivors formed an effective nucleus for future generations, each of which has shown definite increases until now it appears that the original abundance has been attained.

While this rodent is an important buffer species it does not relieve the great stress in the winter because it is then in hibernation. The hibernation period begins early in the autumn—immediately following the first freezing temperatures—, but curiously enough terminates almost as soon as the first patches of bare ground appear in the spring, which is usually about the middle of April. This is just prior

to the arrival of migratory birds and at a time when the raptorial species are having difficulty in acquiring sufficient food to meet the demands coincident with the breeding season.

*Wood duck.* Saunders ('29, p. 472) says that the wood duck has been "Reported by Roosevelt to breed in the St. Regis region, but I did not find it there or elsewhere in the Adirondacks. It is probably less abundant now than it was formerly." Johnson ('37) did not find the wood duck on the Huntington Forest while conducting his field studies, but Mr. O. W. Oja, the Forest Supervisor, acquired a male specimen from a beaver pond near Rich Lake in the autumn of 1937. Both males and females have been observed in limited numbers about the beaver ponds and marshes every summer since.

Young wood ducks have never been positively identified on the Forest, but ducklings that may have been this species were observed on a few occasions among the marsh grasses in the beaver meadows.

**Graduate Research Projects.** The Huntington Forest program makes provision for the teaching of both undergraduate and graduate students majoring in Forest Zoology. Graduate students enter into this program more than others because they must devote the major part of two years on the Forest in acquiring the necessary data for their theses. The Forest is sufficiently diversified in character to provide innumerable problems. It has the important advantage of being completely controlled by the College, which makes available facilities and privileges that would otherwise be difficult if not impossible to obtain.

Some of the problems for graduate theses are not directly concerned with wildlife but rather with phases of the wildlife habitat. The data acquired in connection with these problems often are basic and necessary for the wildlife work conducted on the area. The theses in connection with graduate research are as follows:

1. A management plan for the Archer and Anna Huntington Wild Life Forest Station at Newcomb, N. Y. Progress report on the forest management phase. M.F., Silviculture, 1936. Carl Hammarstrom. The author says that the purposes of the plan are:
  - "1. To present existing information concerning the Huntington Forest upon which this plan is based.
  2. To explain the manner of subdividing the tract, and to state the method of keeping the forest records.
  3. To make general recommendations for the tract as a whole.

4. To assemble information of a general character; in reference to the forest, which will serve as a background for this plan."

Sixteen forest types are recognized and described particularly as regards volume and location.

2. A management plan for the Archer and Anna Huntington Wild Life Forest Station at Newcomb, N. Y. for the period 1937-1947. M.F., Silviculture, 1937. Robert Cron.

In this report "is presented summarized information regarding the timber resources of the Archer and Anna Huntington Wild Life Forest Station with a topographic and forest type map of the tract compiled from student data gathered during the past two years. These constitute the principal basis for the plan and recommendations for management of the tract, designed to combine sustained yield of timber with the purposes set forth in the deed of conveyance".

3. Food producing capacity of the Huntington Forest with respect to deer browsing. M.S., Forest Zoology, 1940. William J. Frank.

"Quantitative data on current annual twig growth which may be applicable to, and correlated with the carrying capacity of a range for whitetail deer." As is frequently the case considerable time and thought were devoted to developing techniques that would not only serve his particular needs, but those of others working on similar projects in other parts of the country.

4. Annotated list of the ferns and flowering plants of the Archer and Anna Huntington Wildlife Forest Station, Necomb, N. Y. M.S., Forest Botany, 1940. Harold F. Heady.

This thesis was published in 1940 as part of volume 7, number 3 of the Roosevelt Wildlife Bulletin. The preface was written by Frank E. Egler who states "Mr. Heady has made very extensive collections on the forest. All previous surveys, notably those of Homer D. House in Newcomb Town, have been investigated. The more complex taxonomic groups have been identified by specialists. All collections have been compared with herbarium material, and annotations have been written specifically for the forest area. It is believed that the bulletin will serve as a source of basic information for future scientific research on the forest." The last sentence of the above quotation is especially pertinent. The bulletin is an important part of each research worker's equipment, regardless of the type of problem with which he is concerned.

5. Adirondack lake shore vegetation. Paper I. Deer Island and Big Wolf Island Permanent quadrats. M.S., Forest Botany, 1940. Charles S. Walters.

These two islands were selected for this study because they represent areas that are relatively unaffected by man. Furthermore they are sufficiently isolated to guard against human visitation other than those actually engaged in conducting studies on the islands. The values of the ecological investigation as outlined in this thesis are "(1) it provides for the continued study of Adirondack lake shore vegetation with the purpose of investigating changes and fluctuations in natural vegetation, and (2) it furnishes information which may be immediately applicable in other fields, especially in the scientific study of mammal and bird life."

6. The effect of deer browsing on forest regeneration in the central Adirondacks with special reference to balsam fir. M.F., Silviculture, 1940. Frank E. Casanova

This study was made in the spruce forest types of a 2000-acre area north of Big Sucker Brook. The purpose of the study was to determine the cause of the absence of the sapling-size class in balsam fir and other species. It was found that spruce and beech, both tolerant of shade, were the two principal species escaping deer browse damage sufficiently to form part of the stand. "Balsam fir, tolerant of shade and heavily browsed by deer, seemingly owes its occasional escape to the large number of seedlings which become established on favorable sites."

7. The red squirrel: territorialism, activities, and census methods. M.S., Forest Zoology, 1941. William Fitzwater.

Most of the data for this thesis were acquired from the Huntington Forest and particularly from the check-area. Studies were also made near Syracuse and on the Cornell University campus, mainly for comparative purposes.

The author experimented with numerous dyes with the object of finding one that could be successfully used in coloring the hair to enable future identification in the field. Considerable data pertinent to territorialism were obtained from the activities of the dyed animals.

8. A quantitative and distributional study of the seasonal availability of certain wildlife foods on the Huntington Forest. M.S., Forest Zoology. A. E. F. Miller.

"The purpose of this investigation is a quantitative determination of the fruit produced by certain species of wildlife plants,

and the distribution of these species in various cover types of the Huntington Forest."

The data were obtained from sample half-milacre plots distributed throughout six forest types. The quantity of fruit from each sample plot was calculated each month during the summer and fall. Final results of this study are not yet available.

9. A study of edge effect in its relation to wildlife distribution and economy. M.S., Forest Zoology. Frank Barick.  
The field data for this study were accumulated this past summer and the thesis will be written during the coming winter.

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# FOREST ZOOLOGY AND ITS RELATION TO A WILDLIFE PROGRAM AS APPLIED ON THE HUNTINGTON FOREST

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Forest zoology is concerned with the animal life of forested areas. Theoretically this is a correct definition but, as frequently happens in this age of specialization, proper definition must provide for delimitation. Forest zoology as actually practiced does not include certain phases of the biology of forest inhabiting groups. For example, forest entomology and the bacteriology of forest soils, because of their high degree of specialization, have become segregated and developed as separate fields. This leaves as the special province of the forest zoologist all of the vertebrate groups and all of the invertebrates excepting the insects, the soil inhabiting protozoa and the ecologically related nematodes.

The work of the forest zoologist is both investigational and applied. Its basis is the pure science of zoology, but it is in the end an applied science, for it must include management and control. It cannot be a pure science for economics thrust themselves into its problems at every turn and cannot be ignored. It is not, however, just game management; the two terms are not synonymous. Forest zoology is more inclusive than game management; it includes, the science and art of game management, but, in addition, is concerned with species not included under the head of "game" and not included in the term "wildlife" as that word is ordinarily understood. Neither is forest zoology limited solely to the control of supposedly harmful species and the reiteration of obvious (or suspected) beneficial traits of forest animals. The whole story of the relation of animals to forest welfare is not found in the depredations of predators, the destructive activities of rodents, the distribution of seeds by birds, and the other equally obvious relations that we have for so long accepted as the animal's only effects on forests.

Forest zoology as a science is concerned with the animals of forested areas—their life histories and habits; their behavior as individuals and as populations; the rôle they themselves play as factors

in their environment; their properties both as species and as total populations; their adaptations and limitations; and their requirements.

Forest zoology as an art is concerned with the control of animal populations; the provision within each environment of the materials essential to the welfare of the animals; and the arrangement of these materials in a manner that will allow for their most productive use.

And finally, forest zoology is concerned in both its research and its practices with those larger principles of forest conservation—sustained yield, multiple land use, and the greatest good to the greatest number. Animal life is one of the organic resources; it is, therefore, subject to management on a sustained yield basis. Few, if any, land areas on which wildlife exists are valueless for other purposes. It is, therefore, imperative that the management of this resource be made to conform with a multiple land use program. The wild animal resource possesses so many values and performs so many services that it is of importance to numerous groups of our citizenry. The interests of these groups vary according to their knowledge and their point-of-view, but it is essential that all of them be taken into account if we are going to provide for the greatest good to the greatest number.

The primary considerations of forest zoology are: (1) the control of injurious species, (2) the encouragement of beneficial species, and (3) provision for those many species which are neither harmful nor beneficial, but which are of interest to some members of the public and which may be, for all we now know, of very great importance to the welfare of the forest. Although these considerations seem fairly simple and their objectives not difficult to accomplish, an examination of the problems involved demonstrates quite adequately the need for increased knowledge.

Perhaps of first importance is a knowledge of species' requirements. It is common knowledge that all animals require food, cover, water and certain special materials. It is not so well known that their needs in these respects differ widely between species, between the two sexes of the same species, between age groups in the same species, according to seasons and according to their varying physiological activities throughout the year. These species' requirements are, in fact, quite different and more complex than they are ordinarily assumed to be. Each environment must contain this great variety of species' requirements during the different seasons for the various activities of both sexes and all age groups of all the species it is intended that the environment shall support. This knowledge of the kinds of animals present in an area, their requirements, and

how to provide for those requirements is not, unfortunately, included in our inherited instincts and neither is it acquired through casual observation and hasty interpretation of animal activities.

The mere fact that an area is covered with a growth of trees and associated underbrush and ground cover does not guarantee the presence of those materials essential to the welfare and productivity of wild animals. Although some animal species occur on most forested areas their presence is not necessarily proof that they are the most desirable species for that area, or that they are the only species that can exist on the area. Neither are the numbers in which they exist any evidence of either the actual or potential productivity of the area.

In discussing this point in connection with game species Leopold (1930) has said "that the repetition of formulas like 'The forest is the home of game' is not a contribution to game management. It would be about as helpful if agronomists said: 'Raise plenty of crops and your livestock will prosper.' Even the layman conservationist will eventually tire of such generalizations. . . . We must remember that 'all generalizations are false, including this one.' Progress in any field may be measured by the rate at which generalizations are broken down and reformulated."

The generalization that good forestry is good wildlife management is true only if the forestry is good in the sense that it has taken into consideration the requirements of the wildlife and bases its practices on actual and accurate knowledge of these requirements. The knowledge acquired while hunting, fishing and trapping is not necessarily accurate knowledge of these requirements. It is instead knowledge of the most effective harvesting methods and is usually little concerned with production. But little more can be said for the knowledge possessed by other outdoors-men. Though such men may work where they have ample opportunity to observe wild animals, their minds are occupied with other concerns and the knowledge of wildlife thus acquired is incomplete and inaccurate. The conclusions based on these observations are at best only approximations and subject to all the errors and uncertainties of such information.

Second in importance to species' requirements are the limitations imposed upon animals by their structure and habits. We recognize many changes in form and function among animals as adaptations. The word adaptation indicates that these changes enable the animal to use to its advantage many of the factors that go to make up its environment, that is to say, it is adapted to its surroundings. It must be remembered, however, that highly specialized adaptations

definitely limit the range of activities of their possessor. There is no gain without some sacrifice. Specialization allows for greater freedom along some lines, but at the same time it restricts within narrow limits activities in other lines. Adaptations are just as truly limitations. These restrictions on behavior give rise in animals to definite sets of habits, which constitute the animal's behavior pattern. This pattern is an expression of the animal's abilities and ordinarily it can be modified only slightly; it is in reality the sum of the responses the animal is compelled to make to its environment.

To know the limitations entailed by the various morphological, physiological and behavioristic adaptations, and to know, in addition, the limitations resulting in and from the several phases of the more or less complicated life histories of animals requires a considerable knowledge of animal biology and a detailed knowledge of the various species one is attempting to manage.

Numerous morphological adaptations come to mind, but these are in general the more obvious and less important ones. Physiological adaptations are equally important and still less well-known; while the existence of behavioristic adaptations is scarcely so much as suspected by anyone other than the zoologist and yet these perhaps have a greater bearing upon the fate of the various species than do either of the first two types mentioned.

This latter type includes such recently discovered animal attributes as cruising radii and saturation points. In another paper the author (King, 1938b) has pointed out that even though all of the food and cover requirements of a particular species of animal are present on an area in sufficient quantity they do not make of that area a habitable range unless they are distributed in such a manner that every one of them occurs within the cruising radius of the species requiring them, and unless they do so occur, the area in question is valueless as far as that species is concerned. This same paper calls attention to the fact that species' saturation points cannot be exceeded for the whole range, neither can they be exceeded for any part of the range, except temporarily. It is obvious, then, that each unit of the range as determined by the species' saturation point must produce its proportion of the total maximum population if the area is to realize its greatest productivity. There can be no permanent crowding of the animals into concentrations in excess of this saturation point, therefore, there can be no blanks in the sense of areas lacking in any single species' requirement, if it is intended that the range shall maintain its maximum population.

These two properties of wild animals—cruising radii and saturation

points—will serve to illustrate species' limitations; and they serve also to illustrate the degree to which one must know wild animal biology in order to properly plan for the management of lands on which such animals occur.

Equally as important as species' requirements and limitations is an understanding of ecological relationships. To understand the simple fact that animals are dependent upon their environment is important, but to make this knowledge the basis of a sound work program requires an understanding of the innumerable relationships involved. And equally important is an understanding and appreciation of the extent to which environments are dependent upon animals. Taylor (1936a) says "It is recognized that all animals depend, in final analysis, on plants. It is coming to be more widely appreciated also that plants in turn depend on animals to a very considerable extent; that process and practice in farming, and especially in wildlife administration, range management and forestry, must increasingly take this reverse dependence into account if well rounded and satisfactory results are to be obtained."

In another article (1927) the same author says "The dynamic viewpoint (of ecology) should not be limited to the vegetation, but should embrace the entire biota. Why merely concede that the strictly logical procedure would be to include the animal life in the materials of ecology? Why not include it without argument or comment? Why not *biota* consistently rather than vegetation? This is not only logical but biological. The time has gone when ecology should be limited to vegetation."

In this same connection Jones (1926) has said "The classification that ecologists must eventually settle upon will be one in which both plants and animals are included in the same communities. The treatment of either group without the other is quite inadequate."

And finally according to Tragardh (1924) "One of the most important results gained by modern biological investigations is the realization of the intimate and close connection which exists between all the living organisms. . . . Each is like a mesh in the large network woven on life's large loom, and is connected with all the other meshes. A little pull in one part of the texture is transmitted to the rest of it and is noticed all over it."

Quoting again from Taylor (1925) in his plea for the study of plants and animals together "The world of nature is a unit. If it is upset or interfered with in one place the entire system is bound to be affected. Before man's appearance the plants and animals had undoubtedly attained a degree of equilibrium. But such human

activities as reclamation of arid lands, grazing and lumbering have thrown the natural system off-balance, leading to unforeseen consequences in many directions which must be studied and controlled if man is to maintain himself and his civilization on anything like the present basis. As Lankester puts it, civilized man has proceeded so far in his interference with extra-human nature, has produced for himself and the living organisms associated with him such a special state of things by his rebellion against natural selection and his defiance of nature's pre-human dispositions, that he must either go on and acquire firmer control of the conditions or perish miserably by the vengeance certain to fall on the half-hearted meddler in great affairs. We may indeed compare civilized man . . . to a successful rebel against nature who by every step forward renders himself liable to greater and greater penalties, and so cannot afford to pause or fail in a single step. In no provinces are disturbing consequences more in evidence than in forestry and grazing . . . while the problems involved are plant problems, of course, there does not seem to have been any very wide appreciation of the fact that they are animal problems, too. . . . Among the animals of importance in this connection are, of course, representatives of various groups, ranging, doubtless, from the protozoa to man." It is safe to say that aside from the consideration given a few species of birds, mammals and fish, in the wildlife programs of the last few years neither foresters nor many zoologists have given serious thought to the animal's dependence on its environment; and as for the environment's dependence on the animals, that is still practically an untouched field. The recognition of these frequently complex relationships and the tracing out of their ramifications requires a broad knowledge of zoology as well as a knowledge of the other sciences that go to make up training in forestry.

To quote again from Taylor (1936b) "The notion that any of the sciences is sharply set off from the others in a watertight compartment is misleading and decidedly not in accordance with the facts. A so-called individual science is merely one of the gateways to universal knowledge." The sum of all the contributions made by all of those who have entered through these many gateways will constitute universal knowledge.

And finally the forest zoologist must possess a knowledge of population properties and behavior. The immediately important questions of control, carrying capacities and saturation points are indissolubly tied in with animal populations; and the equally important but not so well publicized questions of biological control and total populations

are just as much a part of the same general problem. To determine when control of injurious species is necessary, what species are in need of control, and to what extent and how their numbers shall be reduced are questions that can be correctly answered only after taking all of the factors involved into consideration, and, since many of these factors are zoological in nature, it is evident that zoological knowledge will be required for their solution. The question is not one of total protection of so-called beneficial species, nor of complete eradication of so-called pest species. No hard-and-fast catalog of wholly good and wholly bad species can be made. Some are beneficial at certain times and places when occurring in proper numbers, harmful at other times and places, or in all places when present in too great numbers.

There is also the matter of total populations to consider. Although we may determine the carrying capacity of an area for one or several species in which we are interested, or, although we may know the saturation point of a number of species we wish to manage, it does not follow that the provision for range essentials in quantities sufficient to provide for these predetermined numbers will insure the presence of these quantities available to the managed species. There are always the several score of other species occurring on the same area and their total populations are far in excess of those of the managed species. They must eat, find shelter, and provide for their special needs, and these demands on the environment must be met from the stock of materials that provide for the managed species. Any management program must take into account these total populations.

Elimination of this lesser fauna is impossible and would be unwise if it were possible. It would be too expensive, it would disrupt important ecological relationships, it would remove necessary buffer species, it would destroy links in food chains on which certain of the managed species are dependent, and it would remove species of interest to certain groups of people who are as much entitled to their rights and interests as are any other groups.

In addition to this strictly biological knowledge the forest zoologist must have a keen appreciation of the several values possessed by forest animals. The forestry profession in general has quite recently come to accept wildlife as one of the forest resources. This acceptance carries with it the responsibility for the welfare of wildlife on forest areas, and the obligation to provide for this welfare in forest management programs. Theoretically, the responsibility is accepted and

the obligations are being discharged. Actually in many instances the responsibility is evaded and the obligations are ignored.

This situation is due to a number of causes. The more important of these are: Lack of funds; failure to accept wildlife as a responsibility and to modify plans or practices in a manner that will provide for its welfare; lack of conviction that money, time and effort devoted to wildlife is a justifiable expenditure.

It is highly probable that the last point mentioned is the one chiefly responsible for the present situation. It is undoubtedly true that most forest administrators who are lukewarm toward wildlife or actually opposed to its inclusion in their forest programs are so inclined because they are not convinced that it is worthy of such inclusion. It seems, then, that this matter is deserving of consideration, and possibly of additional investigation.

This becomes, then, a question of the *values* possessed by and the *services* performed by wildlife. Can it be demonstrated that these are sufficient to justify the costs in time, labor and money necessary for the conservation and management of this resource? I am afraid the answer must be no—but, only because we are not in agreement as to what constitutes value in this case, and because we have made no conscientious effort to determine and present accurate quantitative data on these matters.

We do not have at this time any reliable estimate as to the total economic value of our wildlife resources, and only the sketchiest sort of knowledge relative to its specific values on particular areas. The information available is so general that it is far from convincing, and in most instances is obviously nothing more than the roughest sort of estimate.

A quotation from the section entitled "Wildlife A Forest Resource" in "A National Plan for American Forestry" (Roberts, 1933) aptly describes this situation. The writer says: "Reliable factual information regarding the full extent of our wildlife resource is sadly lacking. . . . In general the data extant on the quantity and value of wildlife give no more than an inkling of the astonishingly large and widespread importance of the resources. Lack of reliable nation-wide data is in itself sufficient to justify a systematic organized effort to obtain comprehensive information regarding our country's wildlife situation. Common sense demands that working plans not only for the development of this resource but for its coordination with broad plans embracing other forms of land utilization must be based on sound fundamental facts." Although this was written eight years ago it is still true in every respect.

The difficulties in obtaining accurate information of this kind are quite obvious. The nature of the crop, the methods employed in harvesting it, and the many different and sometimes conflicting interests involved account in part for this dearth of accurate information. There has also been, until recently, a marked lack of interest in this problem. As usual in such cases increased interest has resulted in discovering methods for overcoming the difficulties involved. There is now no valid reason why we cannot begin to accumulate accurate and up-to-date statistics relative to the several values of wildlife on both large and small areas. Such information will enable us to determine to what extent we are justified in including or excluding wildlife in or from our forest management programs. The first steps necessary in this direction are: Emphasis on the need for more definite and complete economic information relative to our wildlife resource; to provide an outline with definitions of the various general and more specific values possessed by wildlife to serve as a set of "pigeon holes" where this information can be filed; a method for obtaining this needed information.

Concern over the welfare and future supply of any resource usually increases in direct proportion to the amount of knowledge available relative to the economic value of the resource. The total economic value of our wildlife resource is the sum of its several values plus the worth of the several services it performs. These values and services are all included under six general headings. These are:

1. Commercial values—the income derived from the sale of wild animals or their products, or from direct and controlled use of wild animals and their progeny, and results in either the destruction of the animals, or their transformation from a wild state to a domestic or semi-domestic state, e.g., commercial fishes, furs, fur and game farming, domestication.
2. Recreational values—moneys expended in the pursuit of wildlife in connection with sports and hobbies such as hunting, fishing, hiking, touring, camping (to the extent that these last three are based on the attracting properties of wildlife), collecting (non-scientific), photography (as a hobby). Includes sums expended for equipment, wearing apparel, necessary materials, license fees, transportation, provisions, lodging, guide service, etc. May or may not result in the destruction of the animals.
3. Biological values—the worth of the services rendered man by wild animals, e.g., insect and rodent control, sanitation, suppression of diseases, conversion, pollination, etc. (some of these

services could be performed by man in the absence of animals only by increasing operating costs, but we are totally dependent on wild animals for certain other services.)

4. Social values—the values accruing to the community as a result of the presence of wild animals, e.g., increased opportunity for wholesome and economical outdoor recreation, hobbies, adventure, utilization of leisure time, increased real estate values, income from otherwise idle lands, increased farm income, alleviation of monotony, increased physical and mental health.
5. Esthetic values—the values of objects and places possessing beauty, affording inspiration and opportunities for communion, contributing to the arts through music, poetry, literature and painting, and possessing historical and patriotic significance (in these last-mentioned respects native species of wild animals are similar to sites of physiographic, political, military and biographical interest). These values are largely purely personal but are, nevertheless, of vital concern to practically every one spending any amount of time in the out-of-doors and, in addition, are the values that induce a goodly number to become interested in the out-of-doors.
6. Scientific values—values realized through the use of wildlife as a means for investigating certain fundamental and widespread natural phenomena that may affect man's interests either directly or indirectly; of particular interest to the ecologist, pathologist and sociologist, and indirectly of value to all who benefit by their work.

Some of these values have only recently come to be recognized and as yet, not all of them are appreciated by every one interested in wildlife conservation and management or in forestry in general. Unfortunately there are few statistical data that can be offered to illustrate certain of them or to support the claim that some of them actually exist.

Most individuals recognize only one, or at most two or three of these values, and insist that those they do recognize be given primary, if not exclusive, consideration. This has led to the present situation wherein various organized groups, all intensely interested in wildlife conservation, advocate and demand conservation programs that are antagonistic to each other, incomplete in their provisions, and likely to do more harm than good should they be enacted. These several kinds of conservationists have been more or less definitely labeled. It is only fair to state that in most instances the labels have been applied

by members of the other groups and are not of their own choosing.

Certainly the largest of these groups is the one that might be termed the *laissez-faire* group. Its members are not concerned one way or the other with this matter of natural resources. They may or may not be aware of their existence, and if they are aware of their existence they are satisfied that they will continue to exist or that we can get along perfectly well without them when they cease to exist. They neither recognize nor appreciate any of the above-mentioned values.

A second group includes the so-called sentimentalists. These people are opposed to the use in any form of any resource if such use involves practices that are contrary to their ideas of ethics, morality, the humanities, or even their personal conduct as individuals. They have little regard for the several values listed above, and no regard at all for the rights and beliefs of others.

The third group is made up of protectionists, sometimes called preservationists. These earnest souls are convinced that the chief, if not the only, function of a resource is its continued existence. They apparently place esthetic and scientific values above all others, or else they are convinced that these and these only can be realized. They either are unaware of, or choose to ignore, all other values and services that a resource may possess or perform.

The fourth group is made up of single-use adherents. These are the people who have either deliberately or innocently selected some single manner of utilization and insist that it is, in all places and at all times, the only wise utilization. They are blind both to the needs and rights of others and to the results of their own practices. They do not appreciate the many uses to which a single resource may be put, or the innumerable functions it may perform industrially, socially, and ecologically, and neither do they see the end result of rigid adherence to a single-use program.

The fifth and last group consists of individuals perhaps more properly referred to as conservationists. Members of this group usually recognize and appreciate to a greater or lesser degree all of the values possessed by a resource. They must, however, be separated into two sub-groups; first, those very earnest but nevertheless short-sighted individuals who favor use but are opposed to management, and second, those better informed and more far-seeing individuals who favor both use and management.

It is hardly to be expected that there will be any marked improvement in the public's attitude and any real provision for the proper administration and management of the forest wildlife resource unless

and until those responsible for its administration and management are informed as to the various values possessed by forest animals, the various services performed by them, and unless they are aware also of the value of this resource to at present inarticulate and apparently uninterested groups.

Extensive knowledge of the above-mentioned values and thorough acquaintance with the several conservation groups are not essential for one's personal enjoyment of wildlife, but they are necessary if one is to prepare and administer land use programs that will provide for (a) the greatest good to the greatest number, (b) the largest returns from land use, (c) the best assurance of multiple land use, and (d) sustained yields.

As stated by Taylor (1930) "Everybody is in theoretical agreement, at least, with the administration of lands on the principle of highest use. 'Highest use' is an empty phrase, however, unless we have the economic facts on which to base it."

The questions as to whether or not wildlife is to be included in the forest program, and the extent to which it is to be included must be decided on the basis of economics. Sentiment will not suffice, and is no basis on which to build any part of the program. Are the present and future values of wildlife sufficient to justify inclusion of this resource in our forest programs, and if so what is the total investment we are justified in making in this connection? The answer is dependent upon the total current and potential value of the wildlife on the area in question, and the view one takes of forest management's responsibilities to the community.

The investigation, management and administration of the wildlife resource of the country as a whole, or any specific subdivision of the country, is not only a problem of esthetics and recreation, but a problem of large and growing economic importance. Wildlife is a national resource in many respects answerable to the ordinary rules of investment. It is reasonable then to attempt to determine the capital value of this resource, the annual income derived from it, and the amount of money reinvested in it.

The total annual subscription in cash by Federal and State governments specifically to administer this resource, to insure its maintenance, and to secure a continuation of profits from it probably did not exceed \$12,000,000 up to the time that Pittman-Robertson funds became available. The value of the annual dividend to Americans, considering only the tangible assets, is many times this amount. According to conservative estimates by the Fish and Wildlife Service of the United States Department of the Interior the actual value of the

fur, meat and fish, and the protection provided by birds, mammals and fishes is \$641,000,000 annually. If this is true then the \$12,000,000 per year expended on the administration, maintenance and encouragement of the resource amounts to less than 2% of the actual income that is turned back into the business.

This, however, is not a correct method of computing investment values. The total annual income from our wildlife resource should actually be considered as the return on the investment. This, of course, is true if only the increase is taken and the breeding stock is not reduced. There is evidence at hand to indicate that the \$641,000,000 realized each year is too high, that it includes not only all of the increase but a part of the capital stock. It is perhaps safest to consider that three-fourths of that amount could be taken each year without depleting the resource. Considering then that \$480,000,000 is the annual increment, this sum represents the income on the investment. If we compute this income at the rate of 5% the capital value of the investment is \$9,600,000,000.

An annual expenditure of \$12,000,000 to finance a business of this magnitude means returning  $\frac{1}{8}$  of 1% of its capital value, that is, 12.5 cents for each \$100 is used to perpetuate and protect the investment.

It should be apparent that the mechanism we are here considering is not purely biological—it is in large part economic and social. The purely biological problems are important and numerous. They are, however, the primary concern of the wildlife technician and are being attacked on many fronts. The economic and social problems are not less important; they are, or should be, the primary concern of the administrator; but, unfortunately, we are just beginning to investigate them.

The statement made by Harris (1930) in a slightly different connection perfectly states the case. He says: "In grappling with these problems more than science as we conceive it today is required. These are not problems of biology alone—they are problems of the application of the results of biological research under difficult economic and political conditions. It is here that some new type of man must establish his interests on the frontiers of biology and economics."

The lack of accurate knowledge relative to the various wildlife values is responsible for our failure to recognize certain of these values. This same lack of knowledge is in large part responsible for our failure to fully appreciate some of these values. Referring again to the necessity for substituting economic proof in lieu of sentimental appeal—we can never decide these or any other questions on their

merits until their merits have been fully explored. The statement that wildlife is of sufficient value to justify its inclusion in a land-use program cannot be substantiated until the proof has been adduced. Conversely, the statement that wildlife is *not* of sufficient value to justify its inclusion in a land-use program cannot be substantiated without proof of the actual values involved.

If, because of our convictions or simply to avoid argument, we grant that wildlife is to be included in our programs questions immediately arise relative to the degree of inclusion. What share of the available funds and labor is to be devoted to wildlife interests? To what extent may developments primarily for the benefit of wildlife be permitted to interfere with the development of other resources? If a choice must be made between the degree of consideration accorded wildlife and some other resource which is to be favored?

These and numerous similar questions are bound to arise. They cannot be answered on any logical basis until we possess far more accurate information relative to the several values of wildlife, and until we have comparative data for areas of different kinds in different locations and subjected to different kinds and degrees of use by the public.

Foresters as a group talk considerably about the values of the wildlife resource, agree that it is deserving of consideration, and express a willingness to aid in its conservation and management. Usually, however, when the discussions have reached the point where questions of policy and program must be decided there is considerable conflict between what is frequently termed the practical and the theoretical aspects of the problem.

In general this distinction between the practical and the theoretical can usually be resolved into a difference between what has been accepted as sound practice and what it is now proposed to include in future practices. It seems, therefore, that many of the objectionable, so-called theoretical recommendations might very easily be transformed into acceptable, practical recommendations if it could be shown that the returns on the time, money and effort invested would be sufficient to justify these investments.

If the values mentioned above actually exist, and it is the consensus of those most familiar with the subject that they do, then it should be possible to obtain the statistics necessary to support these claims and to justify the expenditures required to maintain these values, and further, to justify certain changes in previously accepted policies and programs that now are necessary if the resource is to be maintained.

It would seem then, that the obtaining of these statistical data might constitute a worthwhile project. It is not likely that men whose time is otherwise fully occupied will undertake this task. The work, however, might be undertaken as a joint project, making use of the services of foresters, forest zoologists, recreation experts, economists and sociologists. Very likely representatives from not more than two of these fields would have to be actively engaged in the work, but certainly representatives from all of the fields mentioned would have to be consulted for advice.

If these assumptions are correct this project could best be carried on from a college of forestry or similar institution. Under these conditions graduate students working under the direction of staff members could do much of the work, and possibly in some cases use the results as thesis material. The direction, the equipment, the necessary facilities and the man-power are all available in such institutions. The work, however, would have to be cooperative for many of the data would have to be obtained from State departments. Most of it, in fact, from the field through the cooperation of various State agencies.

If such a project were undertaken certainly the first steps necessary are: To outline the scope of the problem; to decide on the method of procedure; to determine the order in which its parts are to be undertaken.

The primary objective would be to determine as accurately as possible the actual values of our forest wildlife on various areas subjected to different kinds and intensities of use. These data would enable us to determine to what extent we are justified in modifying present land-use practices to favor wildlife, and to what extent we are justified in investing money, time and effort in the conservation and management of this resource.

How then does this matter of forest zoology relate to the foresters in the field and the forestry students still in college? There is quite obviously a double relationship in the case of each group. In the case of foresters in the field there is a connection with both administration and with forest practices. In the case of students still in school there is the matter of training in forest zoology as an integral part of their forestry education, and there is also the opportunity open to a few to specialize in this particular phase of forestry.

Discussions of these several relationships may, however, be combined into one general discussion of the need for forest zoologists. Munns (1926) has put the question and answer as follows (I have

taken the liberty of changing his word "biologist" to zoologist). "But what is the forest zoologist? The forest zoologist is the forester with a sound forest training plus special training in zoology and animal ecology so that he also can contribute to proper silviculture from the standpoint of forest animal populations. . . . the forest zoologist would not start on a wholesale destruction of some animal until he was sure that upsetting the natural balance, would not react unfavorably to the forest and not the forest as a stand of trees but the forest with the trees only as a part of the picture, the other parts being first, the other denizens of the woods—birds as well as mammals, insects as well as livestock; and second, the other flora of the forest—the underwood, brush, grass, and herbs; and third, the soil."

Training in forest zoology is necessary if the forester is to conceive of forests as does Graves (1915) when he says, "Forests are more than trees. They are rather land areas on which are associated various forms of plant and animal life. The forester must deal with all. Wild life is as essentially and legitimately a part of his care as are water, wood and forage. Forest administration should be planned with a view to realizing all possible benefits from the land areas handled."

In this connection a statement by the Wildlife Committee of the New England Section of the Society of American Foresters (1935) will bear repeating. Although the statement refers to game and game management it applies equally well to forest wildlife in general and its management. The committee says, "plans for game management, no matter how well worked out, will produce little in the way of results unless those who apply their provisions are interested in game and try to understand its needs. Since forest growth and forest animals are inseparable, the forester has in his activities the means of either favoring or hindering the increase of game species."

An intelligent interest in wildlife and a real understanding of its needs are the result of a knowledge of wildlife biology and an appreciation of wildlife values. Grinnell (1924), in a discussion of wild animal life as a product and as a necessity of forest areas, says "The values pertaining to the original, full complement of animal life are widely diversified." After reviewing the several values discussed earlier in this paper he calls attention to the services rendered the forest by the animals, saying "I am led to believe the forest trees themselves depend for their maintenance in the condition in which we observe them in this age of the world, upon the activities, severally and combined, of the animals which inhabit them now, and which

have inhabited them in the past. The pocket gophers, the ground squirrels, the moles and the badgers are natural cultivators of the soil. It is in considerable degree the result of their presence during long series of years that the ground has been rendered suitable for the growth of not only grasses and herbs but even of shrubs and trees, particularly in the seedling stages of these woody plants. All sorts of vegetable life contribute ultimately to soil accretion by reason of their dead remains being torn to pieces by animals, and the fragments scattered by animals, and these then overlaid by earth brought up by animals from deeper layers. The animals which feature importantly in this comminution are the woodpeckers, chickadees and nuthatches, the tree squirrels, chipmunks and porcupines, the burrowing beetles, termites and ants, and then the burrowing and burying mammals which I have just previously referred to. This process of incorporating organic materials into the soil, accomplished in large measure by animals, is, I cannot help but believe, of both immediate and lasting importance to the welfare of the forests."

Taylor (1935a), on the basis of preliminary counts, has made a tentative estimate of the population and the weight of two orders of mammals, the lagomorphs and the rodents, on the Santa Rita Experimental Range of 50,000 acres. The total number of all these creatures was estimated at 2,150,000 individuals or 43 per acre; the total weight, at 438,436 pounds, or 8.7 pounds per acre. But it is quite possible that these species make up but a small part of the weight of all the animals on the Range. In the same paper he points out "The excreta, hairs, horns, skins, feathers, and other shed parts of animal bodies, and in the end, the bodies themselves entire, are continually being added to soils." He also quotes Shaler to the effect "that the quantity of nutritious bone dust contributed to soils through the death of vertebrate animals, when measured in terms of geologic time, though inconspicuous, is very great."

Darwin (1890) cites Von Heusen's estimate of 133,000 living earthworms per hectare of land, or 53,767 per acre. Darwin's estimate of the amount of earth in the castings of these worms was more than 18 tons to the acre per year under certain conditions. It has been recently estimated that pocket gophers do as much work in soils mixing in five months as earthworms do in five years. Taylor (1935a) is authority for the statement "If the pocket gopher has been active for so short a period geologically as 200,000 years, the soils turn-over, at the rate of 1/10 inch per year, would total 1,700 feet, or the equivalent of 3,400 plowings to a depth of six inches."

The same author quotes Breazeale as follows: "Personally I have

never seen a poor or unproductive soil which contained an abundant fauna. I am daily getting more and more of the opinion that the results which we get with fertilizers are indirect, that is, we fertilize the soil flora and fauna, and not necessarily the crop. There is a weak link in every chain and in many an unproductive soil the absence of fauna may be the weak link. Animals certainly bring life and vitamine-like substances to the soil."

Perhaps enough has been said to illustrate the services performed by wild animals and the importance of understanding as fully as possible their rôle in the environment. The essential nature of this knowledge is well expressed in Taylor's (1935b) words: "It is hard to segregate satisfactorily the factors operating to modify a vegetation or a biotic community. Perhaps it is not always necessary. It is highly essential, however, to recognize as many as possible of the component factors leading to an observed condition. Otherwise research may, through too great concentration on a single aspect, miss some of the critical influences involved; and administration, through imperfect understanding of the community as a whole, may in attempted care for the resource on which attention is concentrated, neglect and even waste other resources of equal value; may, indeed, jeopardize the future conservation of all the resources, including the one that had previously been singled out."

As for the other values possessed by forest wildlife it is certain, as Adams (1926) has pointed out, that the animal crops grown in forests may be made to produce an annual revenue of the utmost value in forestry.

The following comment from Hoyt (1937) excellently summarizes the attitude of the forest zoologist: "Since the beginning of the forestry profession, and increasingly so with the passing of time, the one truly vital qualification of a forester has been the ability to recognize all of the various forest values and to judge accurately the relative importance of each. It is therefore the function of the forester to determine which form of management should take precedence on given areas. Since successful forest management depends upon economy of management secured through skillful but inexpensive manipulation of various factors over wide areas, it follows that the most successful forester will be one who can simultaneously manage correctly all the resources of the forest."

Paraphrasing Taylor (1928) we may state the place and purpose of the forest zoologist as follows: The biota on an area at any given time presents the summation or integration of all the factors acting to

produce it. The processes of to-day shape the results of to-morrow. The forest zoologist should be and doubtless will continue to be a specialist in his restricted field in which he will learn more and more about less and less. But if he is to discharge his true functions he must also cultivate a broad view. He should develop the links between the sciences of zoology, botany, silvics, soil science and physiography, and between the various branches of the arts of forestry, range management and game management. He should know more and more about more and more. The plea for forest zoology is simply one for more adequate workmanship. More thorough instruction in zoo-ecology, and especially in the bio-ecology of forest and range, at forest schools and in the universities generally, is desirable. The higher vertebrates, especially birds and mammals in their various relations to environment should receive more time and attention in the curriculum than they have in the past. So also should the vitally important interactions or coactions between plants and animals, and animals and plants.

Every forestry student should have sufficient training in forest zoology to enable him to appreciate—the diversity of species' requirements; the inherent limitations imposed upon animals; the innumerable relationships existing between the animal and the environment, and the environment and the animal; the complexity of population problems, and the numerous values possessed and services performed by animals. The basis for this training should be a full-year course in general zoology. With that background the remainder of the training could be given in two or three additional one-semester courses. Provision should also be made in each forestry school for a few graduate students to prepare themselves professionally as forest zoologists.

Long continued observation has brought to light many hitherto unknown facts in regard to the life histories, ecology, growth, habits and requirements of wild animals, and as these facts have become known they have been incorporated in the practice of the art of wildlife management. As a result, the art has become more stable. But facts obtained from general observation, though far better than the superstitions which they displace are at best only approximations. Some wildlife managers, aware of the handicap which this inadequate knowledge puts upon their art, have begun searching for more definite and exact knowledge.

This new demand has led to the only true source of facts, *experimentation and research*. Experimental areas have been established,

problems are being studied by exact methods and facts of known value are accumulating, and as they accumulate it becomes possible and necessary to organize and classify them according to proven laws. This systematized accumulation of facts relative to the life histories, ecology, growth, habits and needs of wild animals is the science of wildlife research on which an exact art of wildlife management can be based. It would, of course, be wrong to give the impression that this science is complete, for while enough knowledge has accumulated to constitute the beginnings of a science, there is a tremendous amount of work still to be done. Nevertheless, in such facts as we have, wildlife management has the beginning of a sound foundation.

Welch (1935) in his discussion of the essential nature of limnology has furnished us with an explanation that applies equally well to wildlife research and management. Paraphrasing his remarks the case is stated as follows: To qualify as a science, wildlife research must possess some central, unifying feature which ties the whole subject into a coherent, orderly, organized field. Lacking this requirement, wildlife research will be merely an accumulated mass of data. It is held that the central unifying influence of wildlife research is the *problem of biological productivity*. Wildlife research may therefore be defined as that *branch of science which deals with biological productivity of natural environments and with all of the causal influences which determine it*. Wildlife research is essentially a synthetic science composed of elements some of which extend well beyond the limits of biology as ordinarily conceived. It depends upon the proper application and integration of certain facts, principles, and methods of geology, meteorology, zoology, botany, forestry, agriculture and others to the solution of problems which are, in the end, biological in nature. It is, of course, primarily ecological in its bearing.

Referring again to the biological productivity of natural environments we may accept as the central thesis of wildlife management this matter of productivity. Leopold (1933) has defined productivity as "the rate at which mature breeding stock produces other mature stock, or mature removable crop." Training in wildlife management must, therefore, be primarily concerned with these causal influences determining productivity and methods of controlling them.

The administration of forest areas and the practice of forestry should recognize and include this type of training to the extent that those responsible either acquire the necessary knowledge of the subject or employ those who possess such knowledge.

Granting that wildlife is a resource deserving of consideration in connection with land-use plans, and that the type of training described above will furnish men capable of carrying out the provisions that would of necessity be a part of such plans, what then is the nature of a wildlife management program? The remaining part of this paper includes a discussion of this question, and a description of one such management program developed over the last ten-year period.

It, however, is necessary to point out at this time that neither this nor any other program can be successfully prosecuted or become fully effective until a definite policy has been decided upon.

### THE DISTINCTION BETWEEN POLICY AND PROGRAM

There must be a wildlife policy before there can be a wildlife program. This policy must look forward to objectives. The policy-making body must determine what ends are to be attained, what procedures are applicable, and how existing conditions are to be utilized. Not until these points have been decided is it possible to outline a sound and effective program, for the program is the working plan, the detailed treatment of the manner in which the objectives of the policy are to be accomplished. In others words, the policy is a statement of the architect's vision; the program is the builder's work-sheet to be followed in creating and making real and usable this vision of the architect.

The function of an architect is to create, first mentally, second on paper, and third in reality. These creations must possess beauty, stability and utility. Beauty depends on harmony of parts and with surroundings; stability depends on materials used and method of construction; and utility is dependent also upon materials used, and in addition, on manner of construction. The architect must know first the location the proposed structure is to occupy, second the purpose for which it is being constructed, and third the amount and kinds of materials available before he can begin creating.

Knowing the location, he can plan his structure to harmonize with its surroundings; knowing the purpose for which it is being constructed he can plan for harmony between its parts; and knowing the amount and kinds of materials available, he can then vision a completed structure possessing beauty, stability and utility and constructed at a minimum cost to function for the maximum good in the most economical manner.

Having created this structure mentally, he preserves it in the form

of drawings to serve both as a guide and a guarantee of good faith. From these drawings the builders make their work plans or programs, and although the architect has included in his plans plumbing, electric fixtures, landscaping, painting, masonry, etc., and keeps a close check to see that his plans are being followed, he isn't presumed to know as much about placing a faucet, planting a bush, or laying a walk as is the plumber, gardener or brickmason.

Carrying the analogy still further—if the architect possessed definite knowledge as to the location, the purpose, and the materials available, his completed plans can be considered as final—he will have looked far enough ahead to have taken everything into account and his drawings and notes will not require changing. Only time and effort directed toward accomplishment of the objectives indicated in the drawings are necessary to produce the completed structure.

Similarly a wildlife policy must take account of the future to the extent that it can guide our efforts for considerable time to come. It must be definite and final to the point that it insures our building for certain desirable ends. It must take into account the conditions that now exist, the amount of money available for the work, and what we want to have in the future.

The program must be outlined with these three things in mind and it must give in detail the manner in which present conditions are to be utilized, the purposes for which the funds are to be spent, and the procedures that will be followed in attaining the ends sought. This program, like the builder's work plans, will have to be changed to meet changing market and labor conditions, increases or decreases in personnel, postponements and advances due to various causes, and other unpredictable changes, but the policy remains unchanged.

**The Major Considerations of a Wildlife Policy.** Any wildlife conservation policy must deal largely with present needs, but it must also take account of future needs. It should, above all else, clearly state our attitude toward certain much debated and unsettled questions. The three examples following will suffice to illustrate this point.

(1) Should we continue our war on predators throughout our wildlife environments? Are these carnivorous species to be regarded as utterly valueless and deserving of no consideration in a conservation program? These points must be determined, but not until after we have given due consideration to the value of predators as agents of control and sanitation; not until we have carefully considered the rights of the non-shooting public; and not until we have carefully

weighed the pelt-value of our predacious fur bearers against the losses occasioned by their food habits. The biological value of predators as agents aiding in the control of disease and parasitism, the aesthetic and recreational rights of the non-shooting naturalist and nature-lover, the rights of the scientist interested in all forms of wildlife, and the economic rights of the farm boy and the trapper all enter into this matter.

(2) Are we to continue to distinguish between game and non-game species on the basis of scarcity and abundance alone? That has been the policy in the past and is, in most instances, the attitude at present. Many species have been severely decimated and some have been wholly exterminated before they were removed from the game list. The situation has been accepted as resolving itself into a question of the abundance of the species involved. Might it not more properly be determined on the basis of the success of the management measures applied? Has a conservation policy the right to allow or encourage the serious reduction of a species' population level when we know no method of restoring that level?

(3) Is it our intention to continue with the adoption of more and more of the uncertain and expensive methods for the artificial replenishment of wildlife in an attempt to perpetuate hunting or do we intend to rely more upon the restoration of natural wildlife environments properly managed to accomplish this end? This involves a consideration of and decision on such matters as:

- A. Continued introduction of exotics as opposed to management of native species.
- B. Practically uncontrolled "vermin" control as opposed to replacement of some of the too thoroughly removed natural food and cover.
- C. Increasing dependence on artificial winter feeding as opposed to restoring natural food plants or the providing of non-indigenous but satisfactory foods in a natural way.

In other words, is it our intention to depend in the future on restoration of natural wildlife environments or on uncertain and expensive artificial makeshifts?

These are in every sense questions of policy. They must be decided, along with many others of a like nature, by the policy-making body before a program can be outlined.

Those activities that are directed toward the solution of immediate and widely recognized problems should receive first consideration.

It is proper that they should constitute the major part of the policy. Certainly the general public will look on these activities as the important part of the policy if they do not think of them as the entire policy. Favorable publicity resulting from such activities will go a long way toward allaying public fear and quieting public hysteria, will build up confidence in the policy and will smooth the way for other recommendations and changes. These activities then may well constitute the major considerations of any management policy.

## A WILDLIFE MANAGEMENT PROGRAM

Wildlife management is the art of making land produce sustained annual crops of wildlife in order that we may realize the several values possessed by and utilize the many services performed by this resource. Any wildlife management program must be equally concerned with the two fundamentals—wildlife and land. For purposes of discussion wildlife is, in this instance, accepted as including all wild animals in their full number and variety and possessing their inherent quality of wildness. Land is interpreted as including not only the soil itself but its topography, the vegetation it supports, and the many and varied uses to which it is put. As stated in a previous paper (King, 1938a) "the primary concern of wildlife management is wildlife and its conservation. This, however, cannot be its only concern. Wildlife is so intimately related to other organic and inorganic resources, and so utterly dependent upon them that any consideration of its welfare must perforce include some consideration of the welfare of these other resources. It should be obvious that every wildlife conservation effort is predetermined by the nature, the needs and the activities of the animals we are attempting to conserve. Unless these conservation efforts are based on a knowledge of wild animal biology there can be little hope of success. In addition it must be realized that all wildlife conservation is wholly dependent upon the provision of satisfactory environments, for all wild animals are totally dependent upon the environment in which they live. Every need of the individual and the species must be supplied by the environment; if the environment provides poorly wildlife will be scarce, and if it provides not at all, even in the case of a single need, wildlife will not exist there. And finally, the demands made upon both the environments and the wildlife, the innumerable influences brought to bear upon them, and the various uses to which they are subjected conditions every effort we make at conservation and every response we obtain. These last-mentioned conditioning factors

and influences are all included under the term land uses." In other words wildlife and land include all of the animal organisms plus their total environment.

The several considerations arising from these concepts of wildlife and land may be expressed as the premises on which wildlife management must be based. These are:

1. Wildlife values include all the rights and interests that the various groups of our population have in this resource. Whether or not these groups are organized is a question of no fundamental importance.
2. Wildlife is an organic resource and can be managed on a sustained yield basis.
3. Wildlife is a product of the land, therefore, management practices are conditioned by the other uses to which the land is subject.
4. Wildlife is a commodity and as such is answerable to the ordinary rules of investment.
5. Wildlife cannot be considered separate and apart from its environment. As a consequence its management must make provisions for satisfactory environments.
6. Wildlife environments in most instances have values in themselves in addition to their value to wildlife.
7. Income from wildlife may in some instances be sufficient to offset carrying charges accruing on wildlife environments that are being managed for purposes in addition to wildlife production.
8. Wildlife management is as much concerned with the quality of its products as it is with quantity. It must, therefore, seek to maintain all the varied forms of wildlife indigenous to each region in their normally wild state.
9. Wildlife management must take into account the fact that wild animals are not prescient, their reactions and responses are not always in line with their own best interests; environmental manipulations and population controls are not only frequently desirable but often actually necessary.
10. Wildlife in its varied forms cannot survive unaided in competition with civilization. Civilization first improves, then destroys.
11. Wildlife management must constantly deal not with static conditions but with everchanging conditions, species, environments, attitudes and needs.

12. Wildlife management is so largely a matter of environmental controls that it cannot be divorced from the administration of the land on which the resource occurs.

Any wildlife management program to be complete and usable must be written for a particular area and its recommendations and procedures must be based upon a knowledge of the conditions prevailing on that area. It is possible, however, to outline a program that applies in general to all areas, both large and small, and this general program may well include all of the fundamentals of management. These fundamentals of a wildlife management program are best expressed in the form of answers to the following five basic questions:

1. What is present and where is it?
2. How much of it is present?
3. What is its annual productivity?
4. What, if anything, is wrong?
5. What can be done about it?

**The Five Fundamental Steps of Management.** Keeping in mind the fact that these five questions apply not only to the wildlife but to the land as well, we may organize them, their implications, and their answers into the five fundamental steps of management for any mixture of species on any area. These questions indicate not only the information necessary for management but their sequence indicates the order in which this information should be obtained and applied if management is to be practiced most effectively and economically. Their answers stated in proper sequence constitute the major considerations of a management program.

This program, graphically presented in Figure 100, is a wildlife management plan based upon a wildlife survey and an environmental analysis of the area on which it is to be applied. The five steps are, as indicated:

- I. *Inventory.* This has to do with the *constituents* of both the wildlife populations and the environments, and seeks to answer the question—What is present and where is it?
- II. *Censusing.* This is concerned with the *amount* and *composition* of both the populations and the environments, and attempts to answer the question—How much of it is present?
- III. *Yield Determination.* This is directed toward determining *productivity* and *trend* of both populations and environments, and

# WILDLIFE MANAGEMENT PLAN

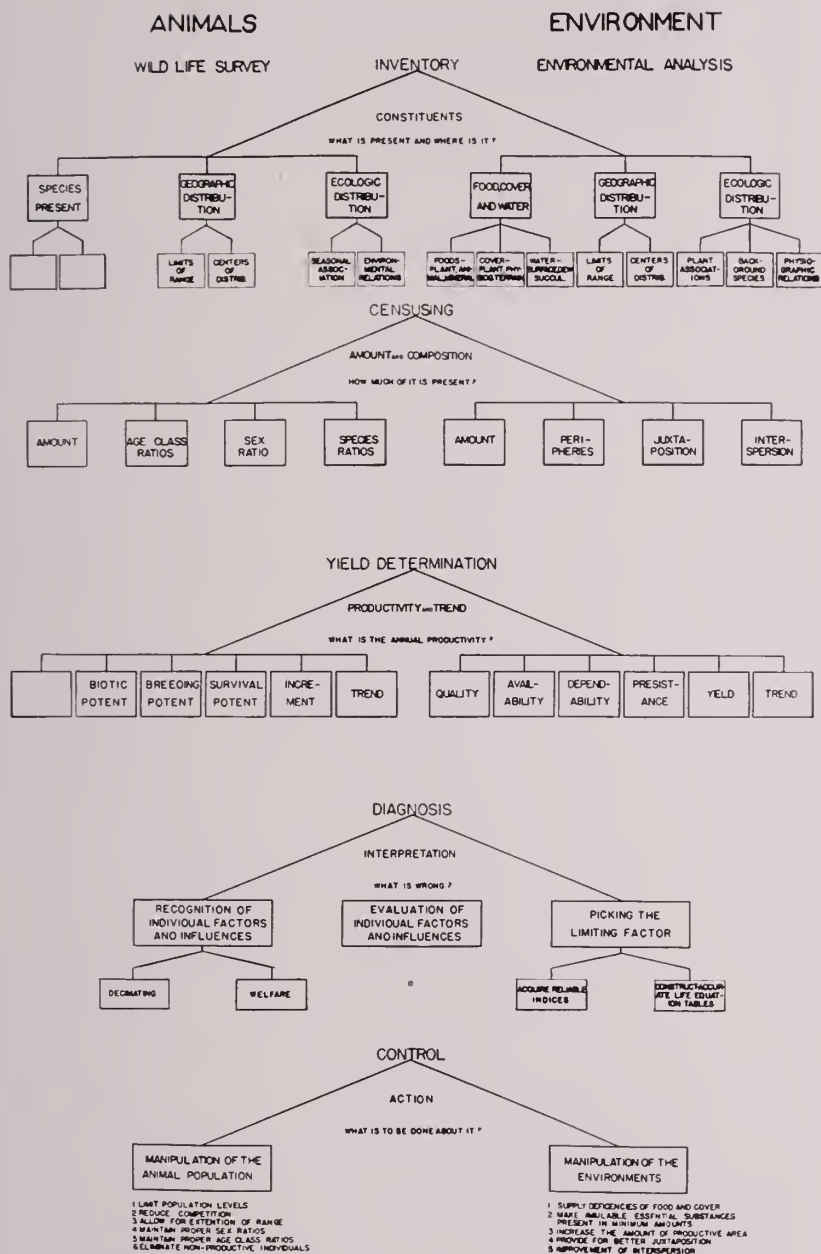


Fig. 100. Wildlife Management Plan.

is intended to furnish the answer to the question—What is the annual productivity?

- IV. *Diagnosis.* This is primarily *interpretation* of the data obtained in carrying out the three preceding steps, and should answer the question—What, if anything, is wrong?
- V. *Control.* This involves the *action* to be taken and is the answer to the question—What is to be done about it?

*Inventory.* The inventory must determine which species of wildlife occur on the area in question and what environments are available to them. In most regions this information, insofar as it applies to the more important plant and animal species, is not difficult to obtain. Ordinarily it involves little more than consultation with mammalogists, ornithologists, foresters and botanists acquainted with the region. This isn't meant to imply that simply compiling a list of species will provide the answer to all the questions relative to predators, foods, buffers, cover, etc., but it does constitute a beginning and is a necessary step if the second and more important part of the inventory is to be accomplished.

This second part of the inventory involves a study of distribution with emphasis on the limits of range for each species of animal and plant, and the center of distribution for each of these species.

The limits of range for each species should be determined for units of area not larger than townships. We should know whether any species occurs in a given township; whether it occurs there every year or only during occasional years; whether it occurs there during the entire year or only a part of the year; whether it has always been present there or has only recently invaded the territory; and whether other species now absent were formerly present.

To be more explicit, certain of our less abundant species and all of our fluctuating species are known to occur in certain regions at times and to be absent from these same regions at other times. These periods of presence and absence may be as short as one or two years or as long as ten or fifteen or more years, and the areas involved range in size from a few sections of land to entire counties or tiers of counties.

These advances and recessions on the boundaries of a species' range, are in many cases a perfectly natural thing and are usually due to a combination of influences. In the case of fluctuating species they are the natural result of the changes in numbers at the various stages of the cycle. What the general result is on the wildlife population as a whole, and what remedial or preventive measures can be applied,

cannot be determined until we have definite knowledge concerning each species and relative to each area involved.

The extension of the range of any species into unoccupied territory is dependent first, upon the presence of favorable conditions in the new territory; second, upon the population pressure exerted by the species in its occupied territory; and third, upon the amount of pressure exerted by adverse factors at the borders of such territory. Elimination or modification of some of these adverse factors would permit certain of our wildlife species to extend their ranges into what is now unoccupied and non-productive regions. As an example, one of the factors operative on range boundaries to retard species' expansion is shooting, and this is a factor that can be partially controlled. If our species' range boundaries were carefully determined and the opening and closing of shooting areas regulated by this knowledge, we would find fewer disgruntled sportsmen complaining of the scarcity of game; we would limit our hunting to the areas best able to support it; and we would allow for this natural expansion of species' ranges resulting eventually in larger hunting areas.

It would be extremely difficult if not actually impossible to conduct a state-wide survey to determine which townships are inhabited by our various wildlife species. Fortunately it isn't necessary to conduct such a survey to determine these points. The game protectors, the forest rangers and patrolmen, and trustworthy local naturalists already possess this information. It is, therefore, only necessary to devise some method that will enable them to conveniently and uniformly record it.

Such a method was devised and successfully used by the writer in connection with the work of the Minnesota ruffed grouse investigation. Two large State maps, showing every township in the State, were procured and each map was marked into districts, one district for each of the cooperating protectors, foresters or naturalists. When the districts had been determined each township in each district was clearly numbered with red ink. Both maps were treated exactly alike and when the district designation and township numbering were completed the two maps were identical in every respect. One of these maps was retained in the office to serve as a base map, the other was cut into its separate districts and each district was sent to the individual responsible for supplying the data for that district.

In addition to the maps each cooperator was supplied with printed forms so constructed that they provided a satisfactory method for the recording of the desired information. The make-up of the printed forms used was as follows:

Cooperator\_\_\_\_\_ Species\_\_\_\_\_

1 TOWNSHIP NAME	2 Twp. No.	3 Range No.	4 Map No.	5 Now Present in Twp.	6 Were Always Present in Twp.	7 Formerly Present; Now Absent	8 Formerly Absent; Now Present	9 Present Only Occa- sionally

The letter of instructions supplied with the forms and the maps explained in detail what information was wanted and how it was to be recorded on the forms.

This method worked satisfactorily for upland game birds and can be made to serve just as satisfactorily for all big game, small game, fur-bearing and predatory species with only slight changes in the letter of instructions to cooperators.

When the completed forms were returned to the central office the data for each species were compiled and tabulated and transferred to the large base map by means of colored map pins. It was then copied on smaller State outline maps and resulted in a collection of maps, one for each species, showing at a glance not only its exact range but in addition all of the points of interest indicated on the printed forms.

If annual changes as they occur are reported and recorded on new maps the accumulated maps for each species show graphically and accurately the shifting range boundaries; they provide a sound basis for determining open and closed shooting areas; they indicate clearly the possibility of extending a species' range into at present unoccupied and non-productive territory; and they provide a means of establishing correlations between population shifts and environmental changes due to fires, drainage, grazing, lumbering, agriculture, hunting, maturing of forest types, and other environmental changes.

In those regions where the General Land Office System of Rectangular Survey has not been used it would be necessary to adopt a different method of designating districts assigned to the cooperators. This, however, would not be a serious difficulty inasmuch as districts are assigned only to those familiar with the areas involved.

Center of distribution in this connection is not used in the sense of a geographic center but instead refers to the center of range as determined by optimum conditions. Because of this distinction, it is quite possible for the range of a species to extend a hundred miles or more in one direction from its center and only a mile or so in another

direction. This being the case, it is obvious that any designation of open or closed areas based on only the reported presence of a species might very conceivably result in open areas in a part of the range that supports but few individuals and miss the area best able to support hunting by a good many miles. The same thing is true of any management measures that might be applied.

This information can be obtained only when we have the range boundaries accurately determined and have censused representative areas throughout the region included within these boundaries.

The distribution of plant species can, if necessary, be determined in much the same way. This, however, is rarely necessary in the case of plants for their distribution is usually better known and the information is available in the form of type maps. Especially is this true for state and national forest and park areas. Advantage should always be taken of such fortunate circumstances as this in every phase of the program. There is nothing to be gained by repeating work already satisfactorily accomplished.

So far the work outlined has dealt only with geographic distribution. This information is essential to any successful management program (except on relatively small areas), but it is not enough in itself. It must be supplemented with information relative to the ecologic distribution of the various species, particularly the local distribution of the various food plants and plant associations providing cover.

The value of a wildlife range is now known to depend more upon interspersion and juxtaposition of types than it does upon plant species granting, of course, that the necessary food plants are present. Wildlife research completed during the past few years has demonstrated conclusively the necessity for revising downward all of our previous estimates of species mobility. It has further demonstrated that practically all species require ready access to two or more types if they are to successfully occupy any given area. Unless the interspersion and juxtaposition of the various types required by the species in question are such as to cause them to occur within the cruising radius of the species then that range is valueless as far as that species is concerned. Fortunately the service rendered by any environmental type is likely to be contained within a very small fraction of that type. This explains why apparently pure types sometimes support fairly dense populations of species with two-, three-, and four-type requirements.

It is indeed fortunate for the majority of our wildlife species that so-called pure stands are very frequently not more than 85 to 90 percent pure. The remaining 10 to 15 percent often consists of plant species providing the only satisfactory food and cover in the entire

area. If this 10 to 15 percent is properly interspersed over the area and is in proper juxtaposition with relation to the other constituents of the area it may make the entire area a habitable and productive wildlife range. In most instances it will be just as productive as it would be if it were 100 percent pure with respect to the food and cover plants.

Knowing then that the success or failure of wildlife environments depends largely upon these factors of interspersion and juxtaposition, and with our rapidly increasing knowledge of the cruising radius of various species, it is clear why management must take into account the matter of ecologic or local distribution.

It is manifestly impossible to map an area as large as the usual state or national forest in sufficient detail to show the extent of interspersion and the degree of juxtaposition that determine the value of the various parts of the area for wildlife range. Detailed maps of such large areas are unnecessary, but detailed maps of representative portions of these areas are essential. Such maps, made on a larger scale and going into greater detail than is customary on the usual forest type map, must be prepared to show such points as the following for trees, underbrush and ground cover: Presence and size of pot-holes; extent and composition of all fringes; presence and size of thickets and species' "islands"; length and width of border types; presence and size of openings due to any cause; type, age class, and varying stand density boundaries; and height of canopy.

Such a map indicates not only interspersion and juxtaposition, but it provides a means of determining the amount of "edge effect" or periphery present and the relation this periphery bears to the other types and to their arrangement. The importance of these peripheries or edges can hardly be over-emphasized. Wildlife is a phenomenon of edges. It occurs for the most part only where the types of food and cover which it needs come together, i.e., where these edges meet. The linear mileage of type edges available in any block of wildlife range is, as a matter of geometry, proportional to the degree of interspersion. Leopold (1933) has expressed mathematically this relationship between interspersion of types, extent of edges, and wildlife distribution as *the law of dispersion*. This law states that the *potential density of game of low radius requiring two or more types is, within ordinary limits, proportional to the sum of the type peripheries*.

Unfortunately the usual forest type map is prepared on too small a scale to show the extent of interspersion, the degree of juxtaposition, and the amount of edge present in the mapped area. This is because wildlife can and does utilize such a small percentage of the total

available environment. No pot-hole, thicket or fringe is too small to contribute its share to the total environment, and very frequently these almost inconspicuously small patches constitute the entire environment as far as successful occupation by wildlife is concerned.

Just as the forester must have a clear conception of site quality as a basis for his silvicultural practices, so must the wildlife manager have a clear conception of interspersions, juxtaposition, and amount of edge for his management practices. This information can be obtained by carefully selecting and mapping, on a large scale, representative areas in the various general types included in the management unit. The Minnesota ruffed grouse investigation has demonstrated the practicability of this method on an area of typical ruffed grouse range. The work was conducted as follows:

An area of 2964 acres of typical ruffed grouse range was selected. Use was made of previously prepared forest type maps and new data in the form of corrections and additions were added to the maps as the work progressed. Lines at one-fourth mile intervals were run across the area both east and west, and north and south. Although these were simply arbitrarily placed lines they provided a very fair sample of the various types included in the area as shown in Table 18. This table gives the forest types occurring on the area, the number of acres of each type, the percentage of the total area occupied by each type, the number of miles of arbitrarily placed line running through each type, and the percentage of the total amount of such line in each type.

TABLE 18. FOREST TYPES ON THE 2964 ACRES OF TYPICAL RUFFED GROUSE RANGE USED IN THE MINNESOTA RUFFED GROUSE INVESTIGATION.

FOREST TYPE	Acres	Percent in Acres	Miles of Line	Percent of Line
Hardwood-conifer.....	884	29.8	10.90	31.70
Jack pine.....	665	22.4	8.62	25.10
Spruce.....	560	18.9	6.81	19.80
Tamarack.....	219	7.4	1.19	3.50
Aspen.....	181	6.1	1.79	5.20
Norway pine.....	101	3.4	1.20	3.50
Swamp-hardwood-conifer.....	73	2.5	0.94	2.70
Open.....	68	2.3	0.53	1.50
Meadow.....	66	2.2	0.65	1.90
Lowland brush.....	65	2.2	0.74	2.10
Muskeg.....	58	1.9	0.67	2.00
Balsam.....	14	0.5	0.28	0.80
	2,954*	99.6	34.32	99.8

\* A number of types of small area totaling 10 acres not included.

Comparison of the figures giving percentage of line with those giving percentage in acres will show how fair a sample of the area is provided by these arbitrarily placed lines. The discrepancy of almost 50 percent in the case of tamarack was corrected by adding another mile of line in this type.

The detailed large scale map was made by traversing these arbitrarily placed lines and mapping all vegetation on a scale of one inch equals 22 yards (one chain). This entailed mapping a strip 41.5 miles long, ten miles of which lay on the boundaries and was 22 yards (one chain) wide; the remaining 31.5 miles lay within the boundaries and was 44 yards (two chains) wide. This gave a total mapped area of 2,826,560 square yards, which constitutes 19.72 percent of the entire 2964 acres. Subtracting 141,328 square yards of duplicated mapping which occurred at the intersections of the lines, there remains a total mapped area without any duplication of 2,722,014 square yards, or 18.97 percent of the 2964 acres.

Thus approximately 19 percent of the total area was mapped along lines which provided a fair sample of all the types present on the area (see Table 18), and this map showed clearly:

Forest types present with their age classes, species' dominants and densities; underbrush types with species' dominants and densities; and ground cover with its species' dominants and densities. Every pot-hole, fringe area, and thicket as large as four yards in circumference or width was included.

Such a map provides detailed and accurate knowledge of food and cover-producing species present, extent and location of peripheries, interspersion, juxtaposition, and details as to age, density and proportionate amount of each species.

If the location of the lines provide a fair sample of the area under consideration then the results can be construed as applying to the whole area, and if the area is representative of an extensive portion of a large block of range or is representative of a large part of the management unit under consideration then they may also be construed as applying throughout that part of this total area.

This mapping can be carried on as rapidly as other kinds of forest type mapping and with the same equipment. It differs from such mapping only in that it gathers data necessary for wildlife management practices. These data are, for reasons stated above, only slightly different in kind but decidedly different in degree from the data ordinarily included on forest type maps.

The establishment on management units of these representative

areas with the location of arbitrarily placed lines serves still other important purposes in wildlife management. One of these purposes is the same as that served by a "normal" forest in forest management. Foresters use these "normal" forests as standards for measuring the conditions of other forests. They base their prediction of the yield from any given area on a comparison with the yield of the best similar area they have measured. "Similar" in this case refers to the occurrence of the same species, age and site qualities. From the measurement of many such optimum tracts foresters have compiled tables called normal yield tables.

As Leopold (1933) has stated, we may measure wildlife productivity on a given range by comparing it with that of the most productive similar range. He further explains that this means eventually setting up for each species in each region ranges which will meet this definition of normalcy, and measuring the populations and productivity on each. Each of these will then serve as a standard with which other areas may be compared. Establishment of representative areas, as already outlined, will meet this need. In addition such areas will provide our only means of accurately censusing many species. This phase of their usefulness to management will be referred to in the following discussion on censusing.

*Censusing.* The second step in management is censusing. Primarily, and at the beginning of management practices, the chief purpose of a census is to determine how many of each species are present on the area under consideration. As management progresses the objectives of the censuses must be increased to include not only the amount of stock present but the composition of this stock as well. Determining the composition of the stock involves the analysis and measurement of wildlife populations in several ways, such as determining sex and age class groups, and determining ratios between sexes, ages, and species present on the area.

Censuses, if management is to be successfully practiced, must not be construed as meaning simply estimates. Unfortunately successful census methods have not yet been devised for all species of wildlife, and few of the available methods are applicable to more than one species. Censusing all of the species on any given area will probably always involve the use of several different census methods; probably in most instances the use of as many different methods as there are species present on the area. These apparent difficulties, however, must not be accepted as justification for a lack of effort to determine accurately the numbers of the various species present on the range.

Practical and accurate methods are available for most of the more important species, and methods less accurate, but far better than estimates, are available for nearly all the remaining species. Censusing techniques for most species of upland game birds are now available and widely used; less accurate but equally practical methods are available for most big game species; and increasingly satisfactory methods are being developed for song and insectivorous birds, waterfowl and many species of small mammals. No really good methods for censusing the fur bearers are known but it is possible to obtain fairly reliable data on their relative abundance. A detailed description of these various methods cannot be included in a presentation such as this. It should be clear, however, that they are simply tools with which the wildlife manager and his assistants must be familiar and which they must use in the course of their management practices.

The important consideration in this connection is that censusing actually be carried on. Guesses and estimates will not suffice. Successful management is dependent upon reliable knowledge relative to what is present on the management area, what is happening to it, and to what extent these happenings are affecting the populations and the environments. The management measures necessary on the area cannot be determined without this accurate knowledge and neither can the success of the measures applied be determined without it. Censusing is the only method whereby such knowledge can be obtained.

The representative areas within management units discussed in connection with ecologic mapping are ideal for census purposes. In fact, censusing on such areas involves, in many instances, nothing more than the following out of the arbitrarily placed lines and the recording of a limited amount of data necessary for the census calculations. Censusing, like ecologic mapping, need not be carried on over the entire management unit, but it must be carried on on representative areas within the unit. As stated earlier in this paper, the amount of stock present on many areas and the probable yield of these areas is determined by comparison with the best similar areas which have been carefully measured.

The two all important points are that fairly representative areas be censused, and that the census be accurately made. In any method where an estimate or guess enters into any part of the census calculation, the final figure cannot be nearer accuracy than was the guess or estimate used. Reliable census methods are not based on estimates. Every factor entering into the calculations has a definite and ascertainable value.

As to the application of this second step to the environments, that is, determining the amount and composition of the various environmental constituents, this is easily accomplished by reference to the data obtained in connection with the inventory. The amount or acreage of each type, and the extent or linear mileage of peripheries can be taken directly from the maps. The degree of juxtaposition and the extent of interspersion may also be determined from the maps and these provide a measure of the composition of the environments. These data are, up to this point, purely quantitative in nature. The discussion immediately following is primarily concerned with qualitative measurements.

*Yield Determination.* The third step in the management program is the determination of yield or productivity. Leopold (1933) defines "productivity as the rate at which breeding stock produces a removable crop or additional breeding stock." Successful wildlife management demands that the yield of wildlife be determined according to time and place. This is just as important and just as necessary in wildlife management as is determination of increment in forestry, measurement of crop production in agriculture, or knowledge of turnover in business.

The determination of yield, insofar as it applies to the wildlife, is necessary if we are to know: Population trends; the success of management measures adopted; the amount of stock that can be harvested and still leave a sufficient breeding reserve; and the extent of the losses occasioned by the combined adverse environmental factors. Without definite knowledge on these points very little in the way of management is possible, and any determination of the amount of stock present is wholly impossible.

The measurement of yield or productivity is accomplished, through the further use of censuses. It involves the use of censuses on the same area one or more times during the year. If the areas or species in question are not to be hunted then a census taken just before the breeding season will determine the amount of breeding stock, i.e., capital or seed, present; a second census taken a year later will determine the percent of increase or annual increment. If the areas or species are to be hunted a second census taken just before the hunting season will determine the percent of increase over the amount of stock present at the beginning of the breeding season. If no increase in breeding reserve is desired the amount of harvestable stock is determined by subtracting from this increase the amount of stock necessary to take account of losses found to occur before the next breeding

season. The remainder is the allowable kill. The losses occurring during any season are ascertained through the use of censuses at the beginning and end of the seasons in question, for example, in the illustration given above a third census taken at the close of the hunting season would determine the hunting loss or take.

In addition to the results obtained from the censusing of wild animal populations, as such, yield determination requires the accumulation of certain other types of information. It is necessary to know in the case of each of the managed species the number of young produced each year. If censusing has determined, as it should, the various age class, sex, and species' ratios, and the numbers in each of these groups, yield determination must carry this one step further and determine the number of eggs per clutch or young per birth, and the number of clutches or births per year per female. It must also determine minimum and maximum breeding ages if these are not already known.

Painstaking accumulation and analyses of these data will enable the wildlife manager to determine for the various species their maximum potential rate of increase, their breeding and survival potentials, their rate of increment, and their population trends. Although only increment and trend appear to be of practical importance neither of these can be properly evaluated, or, what is more important, forecast in advance, without a knowledge of biotic, breeding and survival potentials.

Yield determination insofar as it applies to the environment is a matter of determining the quality of the various food, cover and water resources present. This involves a measure of the availability of these several resources to the various species and age classes and the two sexes according to their seasonal needs, physiological activities, morphological adaptations and behavior patterns. It includes also a determination of the dependability of these resources in one form or another from season to season, and their persistence in usable form throughout the season in which they are needed. Finally it is concerned with yield and trend. As yet little has been done about measuring yield except as it is reflected in the amount of wildlife produced. There is, however, no reason to suppose that measuring yield directly in terms of food and cover produced will prove any more difficult than censusing wildlife populations. Trend is more easily determined, but only after its direction is well defined. There is immediate need for some means of recognizing trend in its earlier stages. This is one of the more urgent reasons for devising some means of measuring the annual production of food and cover directly.

To some extent the quality of the environment is determined by kinds and amounts of foods, coverts and water resources present, the extent of peripheries, and the juxtaposition and interspersion of these several elements. To this extent the results of the inventory and censusing aid in yield determination and full use should be made of them.

The three steps discussed thus far, when carried to completion on any area, constitute a thoroughgoing and comprehensive wildlife survey and environmental analysis. Such a survey and analysis provide information on what is present and on existing conditions. It would be illogical to undertake any program without determining these points. It isn't possible to wipe the slate clean in order to make a fresh start, we must begin with what we have. Present materials constitute the only basis we have to build on, but present conditions can and in many cases should be changed. To determine what the materials and conditions are should be our first concern. A combined wildlife survey and environmental analysis of this or some similar type will provide not only a complete inventory of materials and conditions and indicate their present trend, but will, in addition, aid in avoiding serious mistakes as the work of management progresses.

*Diagnosis.* Diagnosis is the fourth, and in many respects, the most important step in management. In a sense the three steps already discussed are taken as an aid to diagnosis. These earlier steps have values in themselves but their greatest usefulness as separate activities or in combination cannot be realized until this fourth step is taken, and this will be of limited value if not wholly without value unless it is preceded by the others.

The actual presence of the various species, both plant and animal, and their geographic and ecologic distribution as determined by the inventory, their numbers or quantity as determined by censusing and their yield are all dependent upon the action of environmental factors and influences.

The numbers of any animal species on any range are determined by the breeding habits of the species and the environments available to them. Breeding habits are biologically fixed and cannot be changed. This leaves only the one method for increasing the numbers of animals present, namely, modification of the environment so that it more nearly fits the needs of the various species. Practically all species reproduce at a rate that would quickly result in overstocking the range if it were not for the losses that occur between one

breeding season and the next. The difference between this high reproductive potential and the actual survival or productivity is a measure of the environmental resistance.

Environmental resistance is the sum of all the adverse effects of the numerous environmental factors operating against the various species. The only means of bringing about an increase to serve either as an increment to the original stock or as a harvestable portion of such stock is to increase the productivity by reducing the environmental resistance. This reduction can be accomplished only by eliminating certain of the adverse factors or by lessening their harmful effects. In either case the factors must be known.

When the factors are known it will be found that certain losses are unavoidable because the factors responsible for those losses can be neither eliminated nor modified, but it will also be found that other losses are due to factors that can be controlled, at least to some extent. When the relative effects of these factors susceptible to control have been determined it is usually found that relatively few are responsible for the majority of the losses. Their evaluation will indicate which is of primary importance to any species, in any area, at any time. This is properly designated the limiting factor and is the one toward which first control measures should be directed; it is usually the one to which the application of a given amount of effort will pay the highest returns.

Diagnosis is thus seen to consist of three steps: Recognition of individual factors and influences, some of which are beneficial and others injurious; evaluation of the effects of individual factors and influences; and picking the limiting factor. This last is possible only as the wildlife manager acquires reliable indices for his area that enable him to recognize in their early stages conditions that require treatment; and as he constructs life equation tables that enable him to determine the life history stages, age classes and sexes in which his losses occur, and the percent of loss occurring in each case.

Except for the above generalization no hard and fast rules for diagnosis can be laid down. Every area on which wildlife management is to be practiced constitutes a separate problem. Improvement of unsatisfactory situations must be accomplished through the doctoring of "sick" environments, that is, environments lacking in certain wildlife requisites or containing too many wildlife enemies or in some other way out of balance with wildlife requirements. No two areas will ever be exactly alike and no rule-of-thumb methods can possibly suffice for carrying out this most important step in the management program.

At this stage of his work the wildlife manager meets up with much the same situation that confronts the physician in every day of his practice. No two patients are alike, each one is suffering from a different complaint, due to different causes, and requires different treatment. Fortunately the symptoms are usually sufficiently characteristic to provide some clue as to the nature of the ailment. Once this is known the causes can be postulated, the postulates tested, and the results obtained generally indicate the treatment necessary to effect a cure. The physician, however, is able to recognize symptoms only because of his extensive knowledge of anatomy and physiology; he is able to evaluate and attach the proper amount of importance to these symptoms only because of his familiarity with many other cases of a similar nature; and he is able to test his postulates only by means of certain difficult techniques and because of his ability to use certain instruments and mechanisms peculiar to his profession. Without this fundamental knowledge of the human mechanism, without this familiarity with many different cases, and without the techniques and instruments of his profession he would be of no more use to an ailing patient than would any other individual.

So it is with the wildlife manager when he undertakes the task of diagnosis. He must have an extensive knowledge of the biological mechanism, that is, the ecologic set-up with which he is called upon to deal. He must be familiar with other similar cases, their symptoms, the treatment accorded them and the results obtained by such treatment; and he must know the techniques needed for obtaining the facts he wants and for testing his postulates. The various steps described thus far are, in a sense, simply attempts to find, isolate and evaluate symptoms. The wildlife manager must diagnose before he can prescribe remedies and as the remedies must of necessity be applied to the environment, the diagnosis must deal with the environment. Inventories, censuses, distribution studies, food and cover determinations, etc., are techniques used by the wildlife manager in much the same way and for the same purpose that the physician uses his thermometer, stethoscope and blood pressure apparatus in diagnosing human ailments.

*Control.* Control measures are indicated by the results of the diagnosis, and such measures are usually applied to individual factors. They are, of course, intended to effect a cure. Once the factors affecting the population have been recognized and the effects of the individual factors have been determined it will be possible to isolate the limiting factor. This, as stated above, is usually the one

to which the application of a given amount of effort will pay the highest returns. It is not necessarily the one responsible for the greatest loss, as for example, diagnosis may show that in the case of some bird species fifty percent of the annual increase dies within the first thirty days after hatching due to some cause entirely beyond human control, and that ten percent dies at a later date due to some cause easily modified or eliminated. No amount of effort will succeed in reducing to any appreciable extent the very great juvenile mortality, but only a relatively small investment of time and funds may result in almost complete removal of the cause responsible for the losses in the second case. Control then may well be concerned not so much with the obvious as with the practical, and only through proper diagnosis can the practical be ascertained.

It is neither the intention nor the hope of the wildlife manager to save and bring to maturity every young animal born into the world. Such a program would be not only impractical but impossible of accomplishment, and the accomplishment, if it was possible, would be undesirable.

It is the large losses due to the operation of certain adverse environmental factors, or to the presence in minimal amount of certain essential substances, that the wildlife manager seeks to reduce. If the effects of only one or two of these adverse factors could be slightly reduced or if the quantity of these essential substances present in minimal amount could be slightly increased or made more readily available, this would result in the survival of a larger number of animals. As an example, certain of our game birds are known to hatch an average of fourteen young per brood only to have this number reduced to two or less before the next breeding season. As a consequence the population level of the species either remains constant or is slowly lowered. In many cases no great environmental change would be necessary to bring about the survival of an additional one or two of each of these broods. If the changes resulted in the survival of only one extra, it would mean a difference of only 8.33 percent in the mortality rate but a difference of 50 percent in the survival rate and a population increment half again as large as formerly. If two, in addition to the original two, were saved it would mean a difference of less than 17 percent in the mortality rate but a difference of 100 percent in the survival rate.

Controls may be applied to either the animal populations or the environments. They are most frequently applied to the environments, only rarely to animal populations and then only in extreme cases. If, however, environmental controls are carried to the point

of diminishing returns, that is, to the point where further improvement of the environment is not justified, and populations increase beyond the capacity of the range to support them without suffering deterioration, then the only recourse would be population controls and they would become the general practice on such areas.

Population controls are sometimes necessary to limit population levels to the carrying capacity of the range; to reduce competition between species; to reestablish and maintain proper sex and age class ratios; to eliminate non-productive individuals; and, in some instances, to allow for range expansion. Environmental controls are so numerous and so varied that no attempt will be made to list them. In general they serve to increase productivity on occupied areas and provide for extension of species' ranges into unoccupied areas. In both cases the methods used are the same, viz., supplying deficiencies of food and cover; making available essential substances that are entirely lacking or present only in minimum amounts; providing for better juxtaposition; and improving interspersion.

It is evident that controls intended to increase the survival rate consist for the most part of supplying environmental deficiencies and correcting environmental maladjustments. All of these procedures are in the nature of remedies—they are attempts to improve or eliminate unsatisfactory conditions. Such improvements and eliminations result in a higher survival rate because of decreased environmental resistance.

An increase in yield is not, however, a signal for dispensing with the wildlife manager's services. He is not a pilot to be dropped as soon as the voyage is successfully begun. He is, instead, the navigator whose expert guidance is needed during the entire life of the venture. Successful wildlife management can be accomplished only by continued observance of all the rules of good management, and this means carefully and constantly carrying out all the steps of the management program.

If one additional reference to the analogy with medical science is permitted it might be well to point out that the modern attitude in medicine is one of prevention rather than cure. This should be the guiding principle in a wildlife management program, also. Constant attention to the five steps of management will supply knowledge relative to environmental changes, population shifts, receding and expanding range boundaries, sex ratio disturbances, and all of the other symptoms that so plainly indicate functional disturbances in the mechanism we are attempting to control. Early recognition of these symptoms will enable us to avoid serious losses later; and

analysis of the symptoms will indicate the nature of the remedies to be applied.

Fortunately for our attempts at management, wildlife possesses such a high reproductive potential and such a marked recuperative rate that its population responses usually keep pace with environmental improvements. Our wildlife management measures and practices, however, must be determined by the biological limitations of the animals—man is the adaptable factor.

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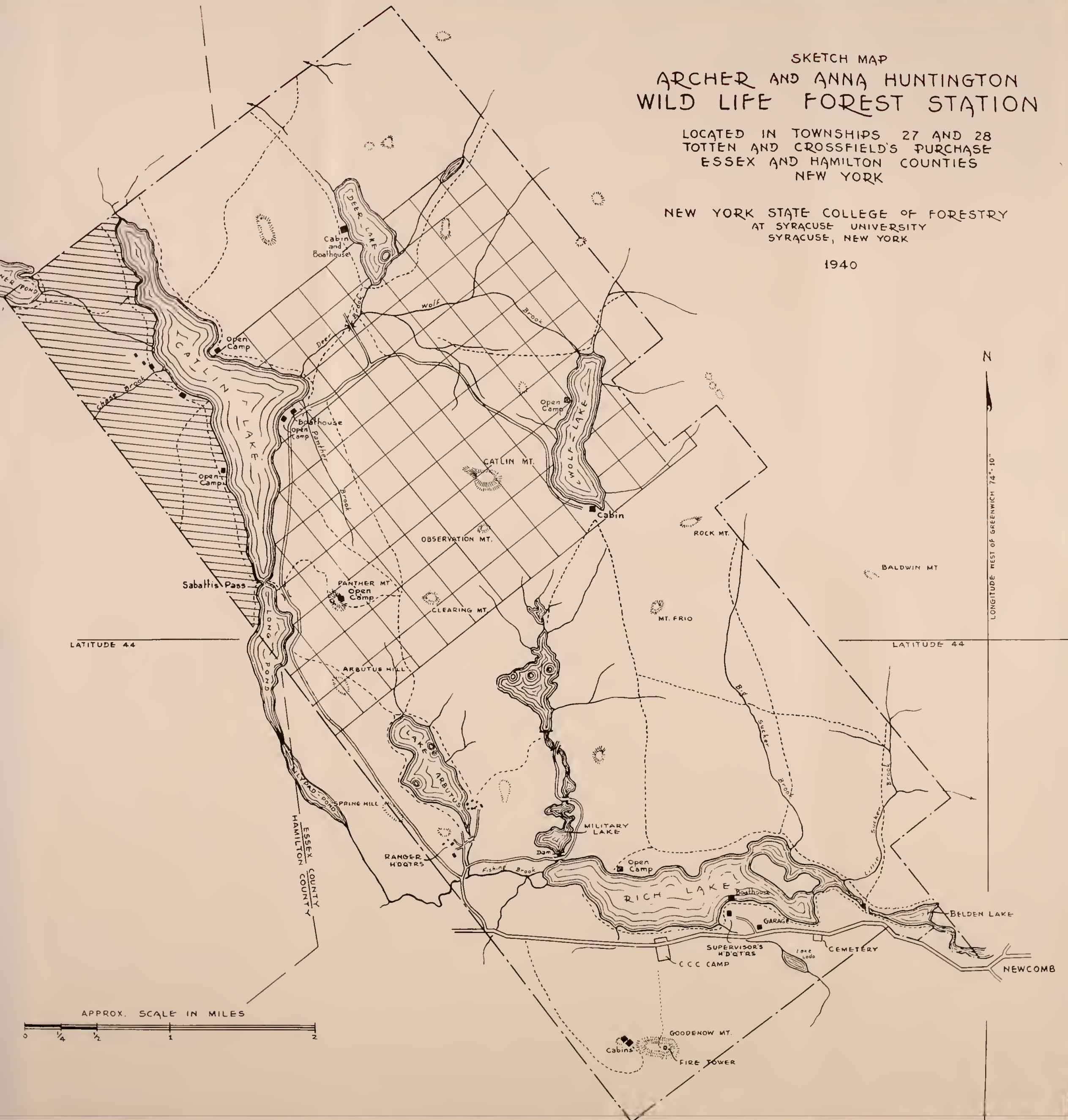


SKETCH MAP  
 ARCHER AND ANNA HUNTINGTON  
 WILD LIFE FOREST STATION

LOCATED IN TOWNSHIPS 27 AND 28  
 TOTTEN AND CROSSFIELD'S PURCHASE  
 ESSEX AND HAMILTON COUNTIES  
 NEW YORK

NEW YORK STATE COLLEGE OF FORESTRY  
 AT SYRACUSE UNIVERSITY  
 SYRACUSE, NEW YORK

1940



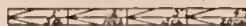
Map 3. Map of the Huntington Forest showing location of "Natural Area" (west of Catlin Lake) and check-area (upper center).



TOPOGRAPHIC MAP  
CHECK AREA  
HUNTINGTON FOREST

NEWCOMB, NY

CONTOUR INTERVAL 10'



FIELD MAPPING BY  
1939 1940

F. BUTCHER	M. ALEXANDER
G. LEE	H. BUTCHER
A. MILLER	F. BUTCHER
D. WAGNER	H. ORLMAN
	M. LEEBROCK
	A. ROBERTS

DRAWN BY  
F. BUTCHER 1940



Map 4. Topographic map of the check-area, completed in 1940.

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## ANNALS

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2. The Food of Trout Stream Insects in Yellowstone Park.....  
Richard A. Muttkowski and Gilbert M. Smith

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1. Ornithology of the Oneida Lake Region; With Reference to the Late Spring and Summer Seasons.....Dayton Stoner

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1. Parasites of Oneida Lake Fishes. Part I. Descriptions of New Genera and New Species.....H. J. Van Cleave and J. F. Mueller

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1. Parasites of Oneida Lake Fishes. Part II. Descriptions of New Species and Some General Taxonomic Considerations, Especially Concerning the Trematode Family Heterophyidae.....  
Justus F. Mueller and Harley J. Van Cleave
2. *Trichodina renicola* (Mueller, 1931), a Ciliate Parasite of the Urinary Bladder of *Esox niger*.....Justus F. Mueller

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Part 3. A Biological and Ecological Survey of the Worm Parasites.  
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